Does an expansionary fiscal policy prevent suicide? Evidence from the Great Depression*

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Abstract

Exploiting regional differences in local public spending during the Great Depression in early 1930s Japan, we examine the impact of expansionary fiscal policies on suicide prevention. Analysis of historical regional panel data from 1899 to 1938 suggests that increased local spending helped mitigate the rise in suicides during the Great Depression. Additionally, we investigate variations in the effects on subgroups defined by industry ratios, revealing stronger mitigation in comparatively urbanized regions. Furthermore, we explore the mechanisms connecting fiscal policy and suicide rates, concluding that economic and familial factors play a significant role.

JEL classification: H53, I18, I38, J21, R23, R29
Keywords: fiscal policy, fiscal stimulus, suicide, Great Depression

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1 Introduction

Suicide is a significant social problem. Suicide is itself a tragic loss. Suicide also has a negative impact on the bereaved family's life. The increase in suicide in society also indicates that people suffering from intense stress and hardship increase.(WHO, 2014)

The role of government in suicide prevention has been a topic of debate among researchers and policymakers. When the COVID-19 crisis broke out, epidemiologists argue that the risk of job loss and financial stressors increase people's risk of suicide and that governments must expand safety net spending which mitigate the risk of unemployment and lead to allocate resources to the economic vulnerable people (Gunnell et al., 2020). A large body of research on economics and epidemiology suggests that the increases in unemployment result in increasing suicide and the government spending decrease the suicide rates in society (Stuckler et al., 2009, 2012; Ruhm, 2000, 2015; Matsubayashi et al., 2020; Huikari and Korhonen, 2021; Chen et al., 2009, 2012, 2015; Breuer, 2015).

This paper examines how an expansionary fiscal policy during the Great Depression in 1930s in Japan decreased suicide. Exploiting an unprecedented local fiscal expansion during the so-called Takahashi Fiscal Policy (Takahashi Zaisei) during 1932 and 1935, we investigate the impact of the expansionary fiscal policy on regional suicide rates. Estimation results using local government statistics from 1899 to 1938 suggest that an increase in local government expenditures decreases the suicide rates, in particular the male suicide rate.

The main contribution of this paper is that we find a clear and robust suicide-mitigating effect of the local fiscal expansion during the Great Depression. A large literature on the Great Depression (Galofré-Vilà et al., 2021; Galofré Vilà, 2020; Matsubayashi et al., 2020; Stuckler et al., 2009, 2012) has not examined this suicide-mitigating impact of fiscal stimulus except for Fishback et al. (2007), and our study provides new evidence on it[1].

In addition, we also contribute to a broader literature on the relationship between fiscal expansion and suicide, by examining it under the circumstance of a sharp and historical policy intervention. Compared with most previous studies in this literature that often rely on regression analysis using panel data and within-region or within-country variations, our study exploits a large three-year policy intervention as an identifying variation. Our findings therefore have straightforward policy implications about how a special counter-cyclical fiscal measure leads to suicide prevention

The rest of the paper is organized as follows. Section 2 provides background information about an expansionary fiscal policy under the Great Depression in Japan with time-series graphs. Section 3 presents the variable description and summary statistics. Section 4 describes our research design, empirical model, and data. In

[1]Fishback et al. (2007) focus on the New Deal policy in prewar US.

Section 5 we present baseline estimation results. Section 6 and section 7 provide some subgroup analyses and robustness checks, respectively. Section 8 examine how the expansionary fiscal policy in early 1930s resulted in suicide prevention. Section 9 concludes.

2 Background

This section summarizes the historical background of Japan's prewar fiscal policy. First, we summarize the history of the shift from austerity policies to expansionary fiscal policies in prewar Japan. Next, we summarize the content of this expansionary fiscal policy, focusing on public works projects.

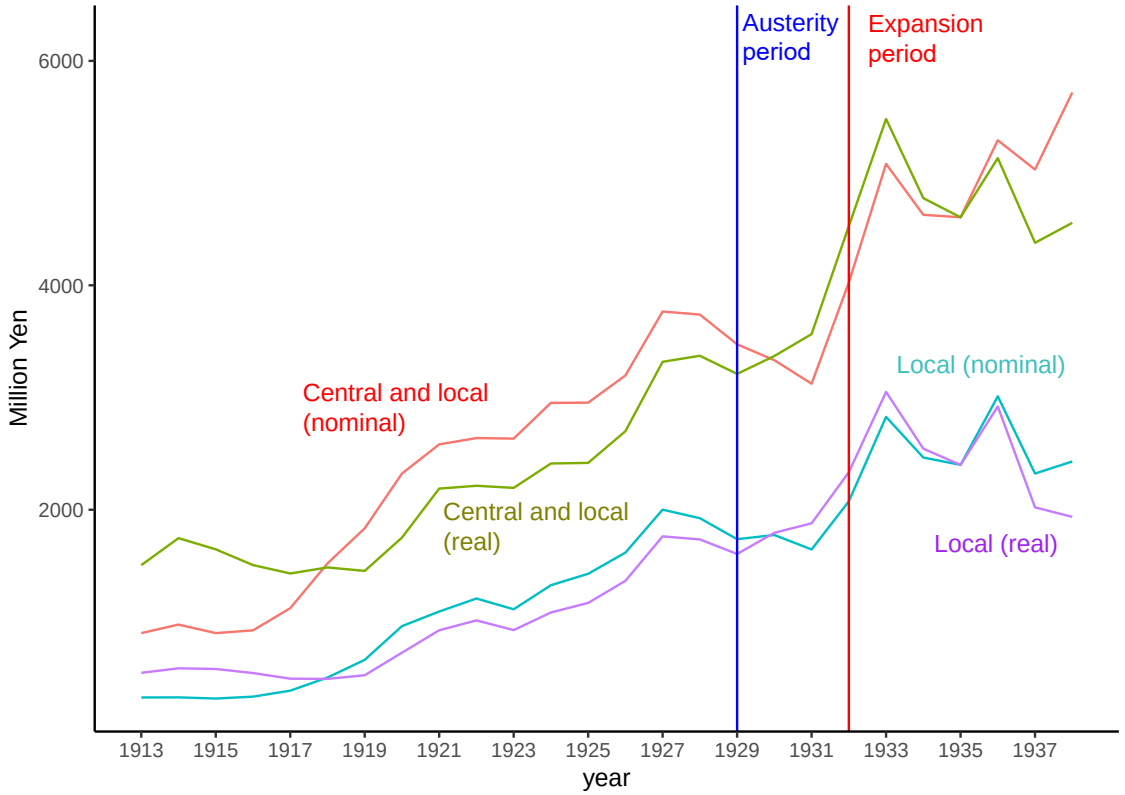
2.1 From Austerity to Expansionary Fiscal Policy

Figure 1 shows the trends in fiscal expenditures of the central and local governments from 1913 to 1938. In this graph, we provide four time-series graphs: total public expenditure of the central and local governments (nominal and real) and total public expenditure of only local governments (nominal and real). One reason why we provide nominal, not only real, statistics is that nominal expenditures more clearly reflect the characteristics of fiscal decision making during the sample period as we discuss below.

In this figure, government expenditures stably increased from 1917 to 1929. During this period, military, industrial, transportation, and educational expenditures and public infrastructure and administrative expenditures contributed to the increase in government spending. Note that expenditures slightly stagnated between 1921 and 1923, partly due to the Washington Naval Disarmament Treaty by which the central government reduced military expenditures. Then the government spending increased from 1923, when the Great Kanto Earthquake occurred. To recover from this disaster, the government increased public infrastructure expenditures from 1924 onward. During this period, education spending also increased, which contributed to the increase in fiscal spending (Hara, 1981).

Then Figure 1 shows that government spending in nominal value declined sharply between 1929 and 1931. The cabinet formed in July 1929, with noue Junnosuke as the Minister of Finance, implemented an austerity policy. The Japanese government decided to return to the gold standard at the prewar exchange rate during this period. This drastic change in the exchange rate led to a decrease in exports and an increase in imports. Therefore, Inoue decided to cut government spending to reduce domestic demand (Nakamura, 1981, pp.122-123). This return to the gold standard lasted from January 11, 1930 to December 13, 1931. As a result of this austerity policy, government spending in nominal terms declined sharply. The government also instructed local governments to cut spending.

Figure 1: Yearly trends of total public expneditures



Notes: A vertical line in 1932 indicates the beginning of Takahashi Economic Policy in Japan. See Section 4 for more details about these data.
Sources: Expenditure data are taken from Hara (1981). We use GDP deflator taken from Fukao et al. (2017).

However, Figure 1 also shows that government spending in real value increased slightly between 1929 and 1931. The increase in real government spending is due to deflation caused by the recession. The Great Depression occurred when the government was implementing a return to the gold standard and this austerity policy.

The austerity policy during the recession and the return to the gold standard worsened the domestic economy. These factors led to a sharp decline in the prices of raw silk and cocoons. For example, rice prices fell by 33% between September and October 1930. In addition to these price declines, bad harvests also occurred. During this period, farmers had debts that were almost twice their annual income (Arimoto and Sakane, 2017, p.149).

In December 1931, the cabinet resigned and Korekiyo Takahashi became the new Minister of Finance (Smethurst, 2007). Immediately, he made the decision to go off the gold standard. Furthermore, starting in 1932, he also implemented fiscal expansion through deficit financing. This fiscal policy led to a sharp increase in military spending and public works spending (Teranishi and Nakamura, 2017; Ide, 2006). Public works spending induced by so called *Takahashi economic policy* resulted in a sharp increase in local government expenditure.

As Figure 1 shows, both central and local government expenditures increased

from 1932. For example, real total public expenditure both in central and local governments increased from around 3,500 million yen in 1931 to around 5,500 million yen in 1933. This fiscal expansion in the ealyr 1930s under the Great Depression is famous and Takahashi is often described as "Japan's Keynes".

However, Figure 1 shows that government spending declined from 1934. In the Takahashi Fiscal Policy period, the period after 1934 is regarded as the austerity policy period (Hara, 1981). In the second half of 1934, the Ministry of Finance began to discuss fiscal consolidation, and after 1934, the upward trend in fiscal expenditures changed. After 1934, military expenditures increased while public works budgets decreased. Based on these historical facts, Ide (2006) calls the period between 1934 and 1936 the late Takahashi fiscal period.

2.2 Fiscal policy and Emergency Relief Program

The centrepiece of the Takahashi Fiscal Policy in the early 1930s was The Emergency Relief Program. This program provided a large amount of fiscal funds to rural areas for local employment and economic stimulus and implemented over the three years from 1932 to 1934, with a total budget of 800 million yen (600 million yen from the central government and 200 million yen from the local governments), plus 800 million yen in loans from the Deposit Department. Compared to the national and local expenditures at the time[2], the amount of money spent on this project was large (Ichikawa, 2012, p.85). Takahashi's fiscal policy, such as the Emergency Relief Program, led to a sharp increase in local government spending. Figure 1 shows real local government expenditure increased from 1932.

The funds of the Emergency Relief Program were spent for public works projects such as riparian protection, improvement of harbour facilities, and building new roads (Smethurst, 2007, p.262). The Emergency Relief Program was abolished in 1934, but other public works expenditures were established after 1935 (Ichikawa, 2012, p.86). After the abolition of the Emergency Relief Program, the central government maintained public works projects in rural areas through loans from the central government and implemented policies to maintain rice prices(Ide, 2006).

2.3 Literature on fiscal expansion effects in 1930s

Several studies have attempted to show the effects of the Takahashi Fiscal Policy in the early 1930s. Nakamura (1981) argues that the public work programs under the Takahashi economic policy led to the economic recovery in 1930s. Cha (2003), using monthly data, shows the fiscal policy in Prewar Japan was contributed to the economic recovery. On the other hands, Kase (1998, 2004), Using historical

[2]The expenditures of both the central and local governments were approximately 2 billion yen

materials and descriptive statistics, points out that public construction relief works for the unemployed in the 1930s did not increase the number of employed workers.

Some studies have shown, in the early 1930s, the monetary policy had an effect, but the fiscal policy had no effect on output. Iida and Okada (2004) argued that a rise of people's expected inflation induced by the announcement of the Bank of Japan's underwriting of government bond led to the economic recovery. Shibamoto and Shizume (2014) shows that the exchange rate adjustment had an impact on the output, using Structural-vector auto regression. Ito (2018) point out that there was no agreement on which policies were most effective in bringing about economic recovery during the Takahashi economic policy period.

3 Data sources and descriptive statistics

While many studies pointed out the fact that Takahashi's fiscal policies increased local government spending, no study examine the effects of this local fiscal expansion on socio-economic outcomes. Due to the scarcity of regional economic data in prewar Japan, it has been challenging to examine this research question.

Using region-level (i.e. prefecture-level) suicide statistics, we address this difficult[3]. As Fishback et al. (2007) point out, suicide data (or mortality data from a variety of causes) is associated with people's socioeconomic situation and financial situation. Therefore region-level suicide statistics can be used as a reliable measure of socio-economic welfare of people living at a certain historical period in a certain area.

We construct dataset that combines the suicide rates, the total government expenditures of all local governments from 1928-1935, and several economic indicators for 47 prefectures from 1899 to 1938. This dataset captures the sharp increase in local government spending induced by Takahashi Fiscal Policy. We use the variation in the increase of local spending to measure the impact of local government spending on the suicide rate.

3.1 Outcome variables

This paper foucus on total, female and male suicide rates. The suicide rate is the number of suicides per 100,000 population. We use the prefecture-level data between 1899 to 1938. Suicide statistics are taken from Statistics on Causes of Death in the Japanese Empire and Vital Statistics of Population in Imperial Japan.

[3]Japanese prefectures are comparable to states in the U.S. and provinces in Canada in the sense that they are the first-tier local governments that include the second-tier local governments such as municipalities within their boundaries.

3.2 Treatment variable

Exploiting the regional variation in the increase of local public expenditure induced by Takahashi Fiscal Policy, we use the increase in local public expenditure induced by Takahashi Fiscal Policy as a continuous treatment variable. We define this variable as the following change in average real local expenditure per capita between 1928–1931 and 1932–1935:

$$FiscalStimulus_i = \frac{1}{4}\sum_{t=1932}^{1935} X_{it} - \frac{1}{4}\sum_{t=1928}^{1931} X_{it} \tag{1}$$

where i indicates prefecture, t indicates year and X is the real local public expenditure per capita. The first term in equation (1) is an average real local expenditure per capita between 1932-1935, which consists of the increase in local public expenditure induced by Takahashi Fiscal Policy. The second term is an average real local expenditure per capita between 1928-1931, reflecting the austerity policy induced by the Inou Zaisei. The difference between these two terms is expected to capture the increase in local public expenditure induced by the Takahashi Fiscal Policy.

Local public expenditure data are the sum of each local government (prefecture, city and municipality) data within the prefecture. The number of the prefecture was 47. We transform all variables into real values[4] and variables per capita. Population data are taken from the Population Census[5]. We interpolate the annual population data using this Census data. We subtract the public debt payment from the local public expenditure.

3.3 Control variables

As explained later, we adopt a difference-in-differences (DID) method with a continuous treatment variable of the Takahashi fiscal expansion. Because our treatment varialbe is not perfectly exogenous, we have collected control variables that should reduce remaining confounding factors in our analysis.

Gross regional agricultural product To control for differences in agricultural economic activity across regions, we estimate the regression model that incorporates cross-sectional covariates, the regional factory output per capita in 1930, interacted with year dummy variables in the analysis period.This data are taken from Prewar Japan Prefectural Gross Product Database[6].

[4]We use GDP deflator taken from Fukao et al. (2017).
[5]This data is obtained from https://www.stat.go.jp/data/chouki/02.html
[6]https://www.ier.hit-u.ac.jp/Japanese/databases/index.html. See Yuan et al. (2009)

Regional factory Output This variable is the output value of factories with five or more employees divided by the population of the prefecture. This variable is considered to reflect the level of industrial activity at the prefecture level. This data does not include the activity of every factory in the prefecture. Given these limitations, this indicator has been used in previous studies as a rough measure of the level of industrial activity in the prefecture (Akiyoshi, 2006). We estimate the regression model that incorporates cross-sectional covariates, the regional factory output per capita in 1930, interacted with year dummy variables in the analysis period.

Regional textile factory Output ratio We estimate the regression model that incorporates cross-sectional covariates, the percentages of reigonal textile factory output in the factory ouput in 1930, interacted with year dummy variables in the analysis period. The policy in Takahashi period caused changes in the exchange rate. This policy benefits the export sector. According to 1930 export statistics, the most exported commodity was textiles. Miwa (2003) indicates that the textile industry benefited especially from the low exchange rate policy during the Takahashi fiscal period. The regional textile industry ratio is included in the model to control for regional differences in export growth due to changes in the exchange rate.

Regional number of military personnel To control for the level of military activity in the prefecture, we included in our model the number of military personnel as a percentage of the prefecture's population. In prewar Japan, military spending by the central government was enormous. Our dataset does not include military expenditures. As a proxy of military activity by prefecture, we used the number of military personnel by prefecture as a percentage of the population. The number of military personnel in the prefectures was taken from the census. We estimate the regression model that incorporates cross-sectional covariates, regional number of military personnel in 1930, interacted with year dummy variables in the analysis period.

Regional machinery factory output ratio To control for the expansionary effect of increased military spending by the central government, we put the machinery factory ouput ratio into our model. The increase in government military spending benefitted regional military-related industries. According to Miwa (2003), increased military spending during the Takahashi fiscal period benefited the machinery and equipment industry, shipbuilding, and heavy chemical plants. Statistics on the machinery and equipment industry are available from factory statistics. In this paper, we add to the model the ratio of machinery and equipment factory output to factory output in 1930, interacted with year dummy variables in the analysis period.

National direct tax revenue The national direct tax data are taken Annual Statistical Report of the Tax Bureau (Shuzeikyoku Tokei Nenposho). This data is available for the years 1902 - 1938. This variable can be seen as a measure of the economic situation at the prefecture. The direct national tax consists of land tax, income tax, and business tax. The land tax is levied on the value of land, the income tax is levied on personal income and corporate income, and the business tax is levied on the business's net profit. Since most of the direct national taxpayers at the time were wealthy, this variable can be seen as measuring the size of the prefecture's income. We included the lag of per capita national direct tax revenue in our estimation.

Gross regional product To control for differences in economic activity across regions, we use the Gross Prefectural Product per capita (based on the 1934-1936 year price). This data are taken from Prewar Japan Prefectural Gross Product Database[7]. This data is available for the years 1874, 1890, 1909, 1925, 1935, and 1940. We estimate the regression model that incorporates cross-sectional covariates, GPP in 1925, interacted with year dummy variables in the analysis period.

Finally Table 1 shows the summary descriptive statistics of our treatment and outcome variables. We use the panel data of 47 prefectures from 1899 to 1938 and the full sample size is 1880. Because the Takahashi intensity variable defined in equation (1) is a time-invariant and cross-sectional variable, we have 47 observations. The outcome variables such as suicide rates include 40-year of data (from 1899 to 1938).

Table 1: Summary Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Takahashi intensity (include public debt payment)	47	6.78	4.38	−3.30	23.81
Takahashi intensity (minus public debt payment)	47	3.73	3.23	-9.30	8.17
Suicide rate (total)	1880	18.53	5.40	0.83	35.86
Suicide rate (female)	1880	13.91	4.82	0.36	30.29
Suicide rate (male)	1880	23.17	6.48	1.24	45.01
Gross agricultural product	1880	4.73	1.30	1.00	10.25
National direct tax revenue	1739	4.29	3.23	0.42	58.67
Factory Output	752	101.30	97.44	7.37	836.45
Gross prefectural product (in 1925)	47	214.30	66.51	107.19	463.94
Regional textile factory Output ratio (in 1930)	47	41.34	24.93	0.59	87.61
Regional number of military personnel (in 1930)	47	351.90	458.57	5.89	2103.52
Regional machinery factory output ratio (in 1930)	47	5.54	11.16	0.19	67.07

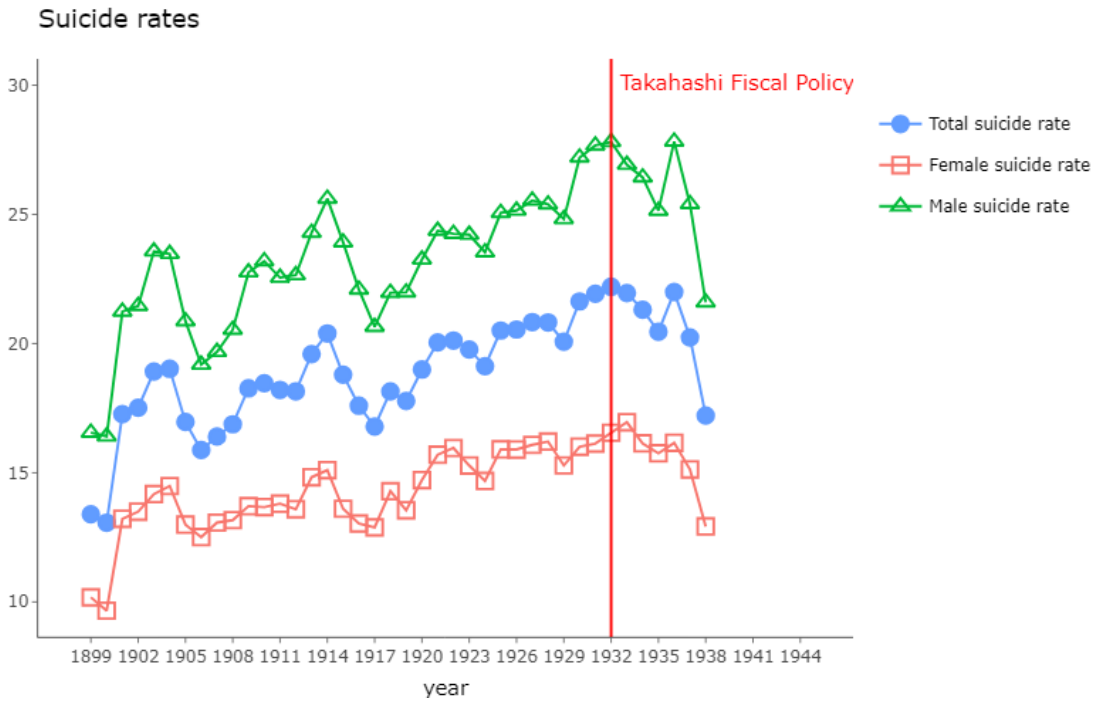
Notes: The Takahashi intensity is a cross-section variable calculated based on equation (1). Suicide rates and number of military personnel are calculated per 100,000 population. For the definition of each variable, see Table A.1 in Appendix A. Outcome variables such as total suicide rates, female suicide rate and male suicide rate
All covariates are per capita variables. Sources: See Table A.1 in Appendix A

[7]https://www.ier.hit-u.ac.jp/Japanese/databases/index.html. See Yuan et al. (2009)

3.4 Data exploration

In this subsection, we provide two graphs which provide some intuitions about our analysis. First, Figure 2 shows the trends of suicide rates. This figure indicates that total, female, male suicide rates increased after 1929, but then gradually decreased after 1932. Second, Figure 3 shows the regional variation of the increase in local expenditure induced by Takahashi Fiscal Policy as equation (1) (panel (a)) and correlations of this the increase in local expenditure and changes in total, female, male suicide rate from in average 1928-1931 to the average of the three corresponding suicide rates in 1932-1935. (panel (b)-(d)). Panel (a) shows that the most affected prefectures are Osaka, Ishikawa, and Aichi. Panel (b)-(d) present some negative correlations between the increase in local government expenditure and the suicide rates.

Figure 2: Yearly trends of Suicide rates



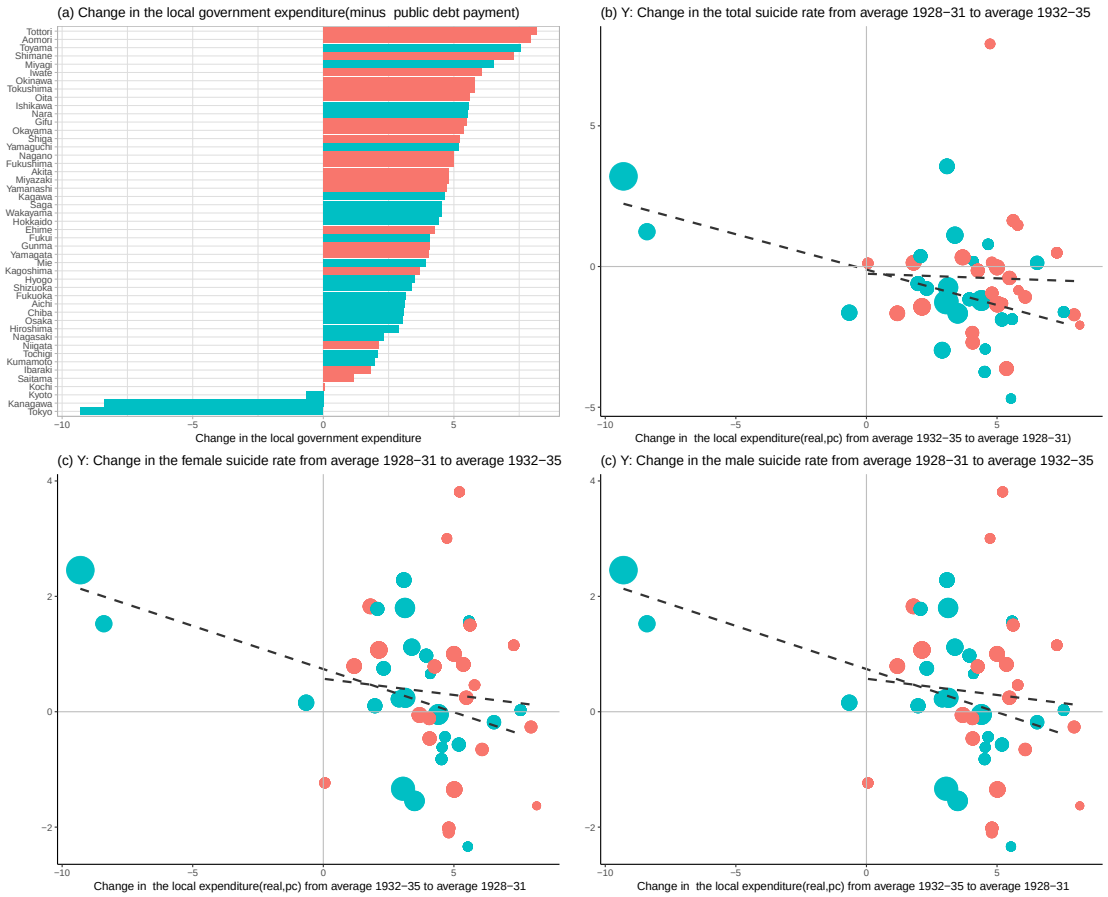
Notes: A vertical line in 1932 indicates the beginning of Takahashi Economic Policy in Japan. See Section 3 for more details about these data.
Sources: Table A.1 in Appendix A

4 Research design

4.1 Empirical strategy and estimation model

In our baseline analysis, we use the following DID model, exploiting the fiscal stimulus under the Takahashi Fiscal Policy as an identifying variation:

Figure 3: Changes in the local government and suicide rates



Notes: A blue (red) bar or plot indicates a prefecture which tertiary industry ratio in 1930 is higher (lower) than the median. In all four graphs, the X axis is the size of an increase in local government defined as in equation (1). The Y axis in panels (b)-(d) is changes in total, female, male suicide rate from in average 1928-1931 to the average of the three corresponding suicide rates in 1932-1935. (panel (b)-(d)). The size of each circle is based on the population size of each prefecture. The dashed line is the fitted linear regression line based on the Ordinary Least Square (OLS) method.
Sources: See Table A.1 in Appendix A

$$\begin{aligned} Y_{it} =& \pi_i + \theta_t + \beta_1 FiscalStimulus_i \times Period1900s_t + \beta_2 FiscalStimulus_i \times Period1910s_t \\ &+ \beta_3 FiscalStimulus_i \times Austerity_t + \beta_4 FiscalStimulus_i \times Expansion_t \\ &+ \beta_5 FiscalStimulus_i \times PostExpansion_t + \varepsilon_{it}, \end{aligned} \tag{2}$$

where Y_{it} is the outcome variable (i.e., suicide rate) for prefecture i at time t, π_i and θ_t are prefecture and year fixed effects, respectively, $FiscalStimulus_i$ is a continuous treatment variable of the increase in the local expenditure as in equation (1). $Period1900s_t$, $Period1910s_t$, $Austerity_t$, $Expansion_t$, and $PostExpansion$ are dummy variables that take one for the period 1900-1910, the period 1911-1919, the fiscal austerity period 1929-1931, the fiscal expansion (i.e. Takahashi Fiscal Policy) period 1932-1935, and the post fiscal expansion period 1936-1939, respectively, and

otherwise zero. The reference period is the period 1920-1928. ε_{it} is an error term.

The coefficient of interest is β_4, which is the coefficient of the interaction term between $FiscalStimulus_i$ and $Expansion_t$. This coefficient captures the correlation between $FiscalStimulus_i$ and the outcome trend from the reference period 1920-1928 to the fiscal expansion period 1931-1935. The coefficents β_1 and β_2 can be interpreted as placebo estimates that are expected to be zero if no confounding trends existed before the fiscal austerity period and the fiscal expansion period. The coefficents β_3 and β_5 captures the correlation between $FiscalStimulus_i$ and the outcome trend from the reference period to the fiscal austerity period and to the post expansion period, respectively. Note that the estimate of β_4 can be interpreted as the average marginal effect of $FiscalStimulus_i$ given that the placebo estimates are around zero and the common trend assumption in the Takahashi Fiscal Policy period is plausible.

In robustness check section, We specify our model as the following event-study specification:

$$Y_{it} = \pi_i + \theta_t + \sum_{\tau \neq 1928} \beta_\tau FiscalStimulus_i \times 1[t = \tau] + \varepsilon_{it}, \tag{3}$$

where Y_{it} is the outcome variable for prefecture i at time t, π_i and θ_t are prefecture and year fixed effects, respectively, $FiscalStimulus_i$ is a continuous treatment variable of the increase in local expenditure as in (1), $1[t = \tau]$ is a dummy variable that takes the value of one if $t = \tau$ and zero otherwise, and ε_{it} is an error term.

The coefficients of interest are the time-varying coefficients β_τ, which capture the correlation between $FiscalStimulus_i$ and the outcome trend from 1928 to time τ. When time τ is before 1928, β_τ can be interpreted as a placebo estimate that is expected to be zero if no confounding trends existed before the Takahashi Fiscal Policy. When year τ is after 1928, β_τ can be seen as the average margina effect of $FiscalStimulus_i$ given that the common trend assumption in the Takahashi Fiscal Policy period is valid. We also present the results of the DID, which use 1931 as the reference year, in the appendix F.

4.2 Control variables

Even if placebo estimates in equation (2) and β_τ before 1928 in equation (3) are around zero, it is possible that some regional factors are correlated with both the increase in local spending defined as equation (1) and the suicide rates under the fiscal expansion. There confounding factors may cause bias in the estimation of β_4 in equation (2) and β_τ after 1928 in equation (3). To mitigate possible confounding bias, we also estimate the regression model that incorporates several covariates.

For these covatiates, we use seven predetermined covariates and three economic-shock variables that are expected to reflect negative economic shocks by the Great

Depression listed in Section . The seven predetermined covariates are meant to control for pre-exisiting regional socio-economic characteristics and the three economic-shock variables are intended to control for direct economic impact by the Great Depression. The seven predetermined covariates are gross regional agricultural product in 1930, Regional factory output in 1930, national direct tax revenue in 1930, Regional textile factory output ratio in 1930, Regional number of military personnel in 1930, Regional machinery factory output ratio in 1930 and gross regional product in 1925.[8] We transform some variables into variables per capita and interact them with year dummy variables in the analysis period. For economic-shock variables during the Great Depression, we construct them as changes in gross regional agricultural product, regional factory output, and national direct tax revenue from 1928 to 1931. We transform all variables into variables per capita and interact them with year dummy variables in the analysis period.

4.3 Weighting and linear trends

In baseline estimations, we use weighted least square (WLS) estimation. That is, we use prefecture-level population sizes as weights and the heterogeneous effect of the fiscal stimulus on an outcome for a larger prefecture is more highly weighted in a DID estimator. This weighting scheme may be appropriate in the sense that it takes into account a population size in each prefecture when calculating an estimate that can be interpreted as an average effect if the identifying assumptions of our difference-in-difference approach is plausible.

As robustness checks, however, we also provide estimation results using the ordinary least square (OLS) estimation method. This is because it is not clear whether a WLS estimator is more appropriate than an OLS estimator as an estimator of a population average effect when effect heterogeneity exists as pointed out by (Solon et al., 2015). We therefore provide both WLS and OLS estimates and compare them (OLS results are in appendix G).

In addition, we also provide esitmation results using a model that also incorporate individual (i.e., prefecturel-level) linear trends. This procedure may further reduce estimation bias that cannot be eliminated by controlling for observed covariates.

[8]We used gross regional product in 1925 because this statistics is available only for 1874, 1890, 1909, 1925, 1935, and 1940.

Table 2: DID estimates for suicide rates, without covariates

	Total	Female	Male
Period 1900s	−0.197*	0.060	−0.376***
	(0.113)	(0.108)	(0.134)
Period 1910s	−0.140**	0.023	−0.242***
	(0.070)	(0.059)	(0.092)
Austerity period(1929-31)	0.091***	0.173***	0.068
	(0.027)	(0.057)	(0.051)
Expansion period(1932-35)	−0.162***	0.041	−0.284***
	(0.055)	(0.061)	(0.065)
Post expansion period(1936-)	−0.178	0.145	−0.330**
	(0.111)	(0.103)	(0.131)
Num.Obs.	1880	1880	1880
R2	0.857	0.825	0.810
R2 Adj.	0.849	0.816	0.800

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. Sources: See Table A.1 in Appendix A

5 Results

5.1 Baseline results

Table 2 and Table D.1 present the results of the DID estimation without covariates. Each row in the tables reports the estimated coefficients on the interaction term between the treatment variable and each period dummy. Table 2 and Table D.1 are based on the same model specification as in equation (2) except that DID estimates in the expansion period is splited into two periods (1932-33 and 1934-35) in Table D.1.

Estimation results in both Table 2 and D.2 shows that DID esitimates in the expansion period are often negative and significantly different from zero, but the placebo estimates in the period 1900s and period 1910s are also statistically significant. These results suggest that confounding outcome trends exists in these period, implying that the common trend assumption is not pluasible.

Next, Tables 3 and D.2 present DID estimates based on a model that controls for the observed covariates listed in Section 4.2. These two tables correspond to Table 2 and Table D.1, respectively. First of all, placebo estimates in the pre-Austerity and pre-Expansion periods are not statistically significant, suggesting confounding

Table 3: DID estimates for suicde rates, with covariates

	Total	Female	Male
Period 1900s	−0.029	0.065	−0.115
	(0.101)	(0.116)	(0.108)
Period 1910s	−0.020	0.057	−0.107
	(0.067)	(0.078)	(0.080)
Austerity period(1929-31)	−0.021	0.120	−0.107
	(0.056)	(0.090)	(0.094)
Expansion period(1932-35)	−0.278***	−0.061	−0.455***
	(0.092)	(0.065)	(0.156)
Post expansion period(1936-)	−0.142**	0.053	−0.280***
	(0.065)	(0.066)	(0.102)
Num.Obs.	1869	1869	1869
R2	0.911	0.870	0.873
R2 Adj.	0.880	0.825	0.829

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

outcome trends are effectively controlled for by the additional control variables.

When it comes to DID estimates for the total, female, and male suicide rates in the expansion and the post expansion period, they are all negative and mostly significantly different from zero. These results imply the possibility that the fisal expansion of local government expenditure may have reduced the suicide rates in 1930s.

Based on the estimates in Table 3, the effect sizes of the increase in local government expenditure are -0.278 (total suicide rate) and -0.455 (male suicide rate) in the expansion period (1932-35). These results imply that if the level of fiscal stimulus during the expansion period had been 8 (like Tottori and Aomori prefectures) instead of around 0 (like Kochi prefecture), total suicide could have decreased by 2 person per 100,000 population, and male suicide could have decreased by around 4 person per 100,000 population.

Table 4: DID estimates for suicide rates with covariates, by tertiary industry ratio

	tertiary industry ratio above median			tertiary industry ratio below median		
	(1)Total	(2)Female	(3)Male	(4)Total	(5)Female	(6)Male
Period 1900s	0.034	0.193	−0.104	−0.074	−0.001	−0.086
	(0.152)	(0.177)	(0.154)	(0.209)	(0.154)	(0.333)
Period 1910s	0.013	0.112	−0.091	−0.188	−0.006	−0.377**
	(0.057)	(0.070)	(0.087)	(0.143)	(0.164)	(0.190)
Austerity period(1929-31)	−0.045	0.150	−0.200**	−0.086	−0.032	−0.029
	(0.064)	(0.101)	(0.088)	(0.167)	(0.222)	(0.254)
Expansion period (1932-35)	−0.412***	−0.120	−0.666***	−0.276	−0.106	−0.416**
	(0.097)	(0.090)	(0.171)	(0.218)	(0.237)	(0.211)
Post expansion period(1936-)	−0.228***	0.020	−0.415***	−0.097	−0.020	−0.094
	(0.076)	(0.103)	(0.096)	(0.222)	(0.199)	(0.300)
Num.Obs.	949	949	949	920	920	920
R2	0.931	0.896	0.902	0.945	0.920	0.916
R2 Adj.	0.868	0.799	0.811	0.892	0.841	0.834

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

6 Subgroup analyses

To understand the mechanism behind the relationship between the increase in fiscal stimulus and the suicide rate, we implement subgroup analyses in which we split the 47 prefectures into the above-median group (24 observations) and the below-median group (23 observations) based on regional industry-ratio indices. That is, using the percentages of employees in the tertiary (or service) industries in 1930, we split the prefectures into two groups based on median and implement the same regression estimation as in the baseline estimation. The data of industry-ratio indices are constructed by the data in Bureau of Statistics Office of the Prime Minister (1973).

Table 4 shows estimation results for avobe-mean and below-mean samples respectively(column (1)-(3) and column(4)-(6)). These results imply that the baseline results may be driven by above-median (i.e. more urban) prefectures, although DID estimate for the male suicide rate in below-median (i.e. less urban) prefectures is also negative and statistically significant.

Figure 3 helps in the understanding of these results. Figure shows 3 that the fiscal stimulus of urban prefectures such as Tokyo, Kanagawa, and Kyoto decreased from 1928 to 1935. In particular, the fiscal stimulus decreased markedly from 1928 to 1935 in Tokyo and Kanagawa, whereas it increased in the other prefectures. From 1920s, big cities implemented policies to help the unemployed, but the sizes of these

expenditures were relatively small. In the sample of tertiary industry ratio above the median, the differences between the fiscal contraction in Tokyo and Kanagawa prefectures and the fiscal expansion in the other prefectures may contribute to the results in Table 4.

Another important finding is that a DID estimate for male suicide with the "less urban" (i.e. below the tertiary industry median) sample is negative and significantly different from zero in the expansionary period, 1932-1935 (column 6). We interpret this result as an indication that fiscal stimulus prevents male suicide increases in rural areas, which were the main target of the fiscal expansion during 1932-1935 (see Section 2).

7 Robustness check

This section provides three different types of robustness checks. First, we provide estimation resutls with evnet-study DID estimation. Second, we present DID estimates with a different treatment definition. Third, we show DID estimates based on the model that incorporate prefecture-level linear trends.

7.1 Event study DID

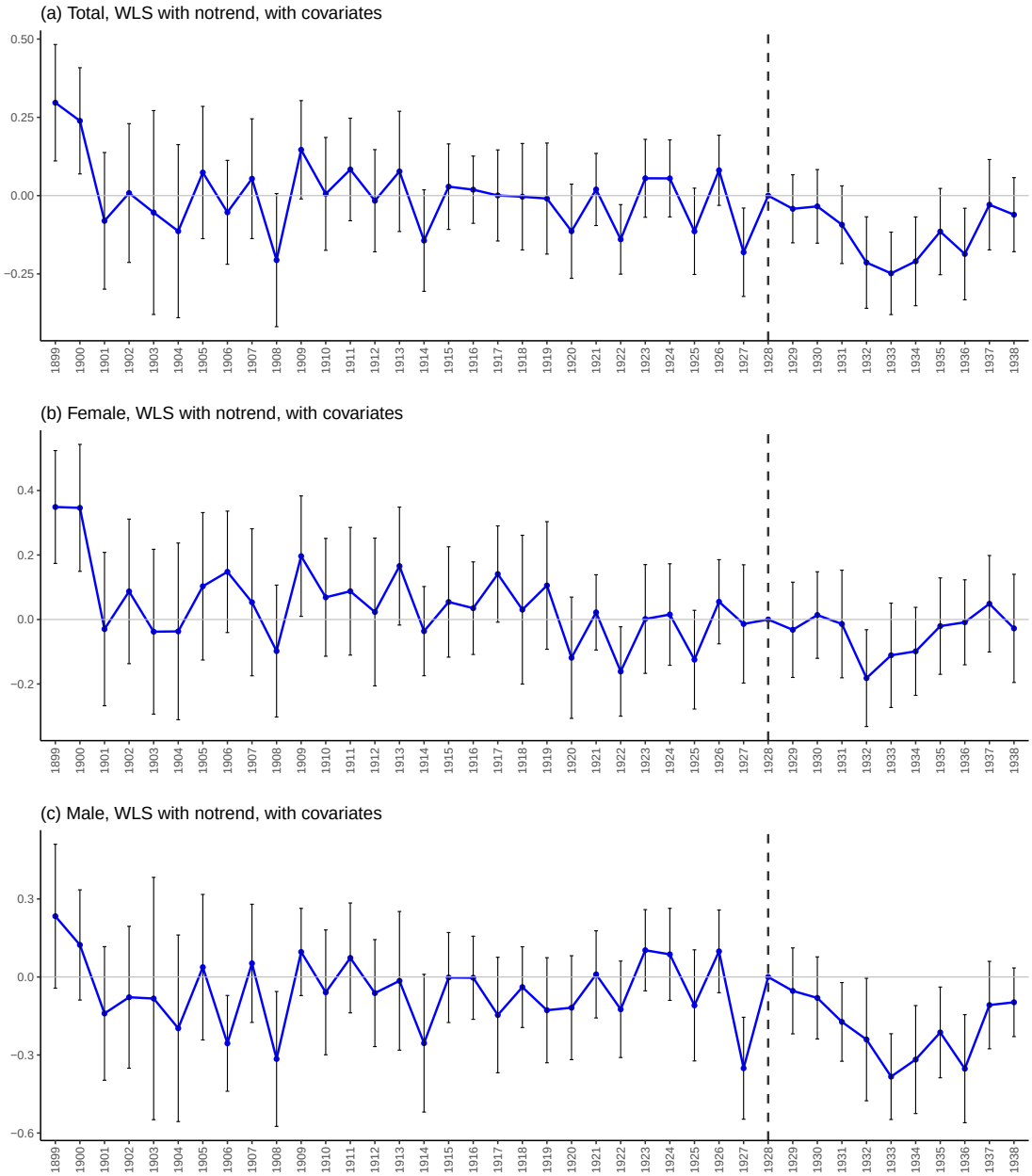
Our main findings are robust to several different model spesifications. Figure 4 presents estimation results of event study DID based on model (3). This figure shows event-study DID estimates using the model with covariates and the figure E.3 in appendix E presents event-study DID estimates using the model without covariates.

First, as is the baseline analysis, some pre-trends (i.e. confounding outcome trends) exist if we do not control for the observed covariates (left graphs). Second, however, once controling for the observed covaraites, pre-trends dissapper (right graphs). Third, when it comes to DID estimates during the fiscal expansion period (1932-1935), they are consistently negative and often significantly different from zero. These results indicate some robustness of our primary findings in the baseline analysis.

The upper bounds of the 95% confidence intervals are often below or near zero, in particular in 1933.

Figure F.4 in appendix F shows the result of event study DID which use the 1931 as the reference year. Our basic results are robust regardless of the different reference year.

Figure 4: DID estimates for suicide rates



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variables are the total suicide rate, female suicide rate, and male suicide rate. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

7.2 A different treatment definition

This subsection presents the estimation results using an alternative treatment variable. As the baseline treatment variable of the fiscal stimulus, we use the change in the real per capita local government spending subtracted by public debt payment. This variable is a simple and transparent measure of fiscal expansion, but this may include some irrelevant fiscal components.

In order to capture the more precise magnitude of local fiscal expansion that

Table 5: DID esitmates for suicide rates, with covariates & diff. treatment

	Total	Female	Male
Period 1900s	−0.105	0.040	−0.222
	(0.167)	(0.152)	(0.217)
Period 1910s	−0.045	0.090	−0.187
	(0.111)	(0.111)	(0.142)
Austerity period(1929-31)	−0.071	0.105	−0.175
	(0.086)	(0.125)	(0.136)
Expansion period(1932-35)	−0.466***	−0.168*	−0.698***
	(0.137)	(0.097)	(0.223)
Post Expansion period(1936-)	−0.261**	0.058	−0.469***
	(0.117)	(0.113)	(0.166)
Num.Obs.	1869	1869	1869
R2	0.911	0.870	0.873
R2 Adj.	0.880	0.825	0.829

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the sum of "public works" and "promotion of agriculture, commerce and industry" expenditures. defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

directly affects local economy, we adopt the sum of "public works" and "promotion of agriculture, commerce and industry" expenditures (real value per capita) as an alternative treatment variable. During the Takahashi Fiscal Policy period, public works expenditures increased in order to provide people with cash and employment. Expenditures for promotion of agriculture, commerce and industry are an indicator of local government support for commercial and industry. We believe that these expenditures benefit rural areas. Therefore, the sum of both variables is an appropriate alternative indicator to reflect the increase in local government expenditures during Takahashi Fiscal Policy period.

Table 5 shows the results of WLS estimate with covariates using the sum of "public works" and "promotion of agriculture, commerce and industry" expenditures (real value per capita) . First, as with the baseline results with covariates, Table 5 shows that some placebo estimates are not significantly different from zero. Second, this table shows that after the introduction of the Takahashi Fiscal Policy, DID esitmates are negative. Our basic results are valid regardless of the definition of treatment variable.

Table 6: DID estimates for suicde rates, with covariates & linear trends

	Total	Female	Male
Period 1900s	−0.038	0.119	−0.150
	(0.126)	(0.187)	(0.169)
Period 1910s	−0.079	0.050	−0.180*
	(0.080)	(0.119)	(0.101)
Austerity period(1929-31)	0.019	0.124	−0.058
	(0.067)	(0.103)	(0.102)
Expansion period(1932-35)	−0.207*	−0.055	−0.367**
	(0.113)	(0.124)	(0.181)
Post expansion period(1936-)	−0.037	0.062	−0.151
	(0.108)	(0.143)	(0.157)
Num.Obs.	1869	1869	1869
R2	0.931	0.885	0.898
R2 Adj.	0.905	0.841	0.859

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size and prefectural linear trends are incorporated. The treatment variable is the size of an increase in local government defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

7.3 Prefecture liner trends

Table 6 reports estimation results based on the model in which prefecture-level linear trends are added to the baseline covariates. The results also show that DID estimates for total and male suicide rates in the Expansion period (1932-1935) are negative and significantly different from zero when prefecuture linear trends are incoporated.

8 Mechanism

In this section, we examine how the expansionary fiscal policy in early 1930s resulted in suicide prevention. Our subgroup analysis in the last section implies that the main pathway from the fiscal policy on suicide were not only through public works and poverty reduction in rural areas, but through counterpart programs (or lack of them) in urban areas. In order to verify that this implication is plausible, we conduct the following analysis. First, we estimate the impact of the fiscal stimulus on the suicide rates by occupation and industry classification. Cause of death statistics in prewar Japan reported the occupation of the deceased or the occupation of the deceased's household. In Section 8.1, we analyze which occupations were affected

by the fiscal stimulus. Second, in Section 8.2 we examine several mediating socio-economic factors that can be affected by fiscal stimulus and also be directly or indirectly associated with the occurence of suicide.

In summary, our analysis in this section suggests the following mechanism: an expansion of fiscal expenditure in relatively urbanized areas leads to the stabilization and improvement of the economic and familial conditions of the unemployed and workers in these areas, which in turn results in a decrease in suicide rates.

8.1 Suicide rates by occupation and industry classification

In this section, we estimate the impact of fiscal spending on suicide rates by occupation and industry. The data on suicides by occupation was obtained from cause-of-death statistics (Nihon Teikoku Shiin Tokei and Shiin Tokei) from 1923 to 1936. The relationship between fiscal stimulus and suicide rates by occupation and industrial classification was analyzed using the event study DID.

Suicides by the employed were defined as those employed in some occupation at the time of death, while suicides by the non-employed were individuals not employed in a particular occupation. Using suicide rates by occupation and industry as the outcome variable, we can estimate the impact of fiscal stimulus on individuals with and without occupation at the time of suicide.

From 1923 to 1931, these statistics divided the deaths into two categories: the employed and the non-employed family. The employed death are then classified into ten occupations: agriculture, fishery, mining, manufacturing & construction, commerce, transport, public service & professionals, other, and domestic service, and non-employed. The non-employed in the category of the employed consisted of the non-employed with income (e.g., those who receive income from tenant farmers' fees, those who receive income from land rent, and those who receive benefits/pensions, or other income) and the non-employed (students, those in psychiatric hospitals, prisoners, etc.).

In the cause-of-death statistics from 1932 to 1936, the non-employed disappeared from the occupational category of the employed. In addition, the category of non-employed family death category was eliminated, and a new category — non-employed death was created in the cause-of-death statistics from 1932 to 1936. Table 7 summarizes the occupational classification of the cause of death statistics.

In the statistics from 1923 to 1931, we defined the non-employed as the sum of the non-employed in the employed category and non-employed family members. We believe the data for non-employed suicide from 1923 to 1931 (the sum of the non-employed in the employed category and non-employed family members) are nearly identical to the non-employed suicide since 1932. The 1932 Vital Statistics report calculated the number of non-employed death in 1931 in roughly the same way as we do.

Table 7: Occupation classification in cause of death statistics for 1923-1931 and 1932-1936

Occupational Classification of Suicides from 1923 to 1931		Occupational Classification of Suicides from 1932 to 1936	
category	sub category	category	sub category
Employed	Agriculture	Employed	Agriculture
	Fishery		Fishery
	Mining		Mining
	Manufacturing and construction		Manufacturing and construction
	Commerce		Commerce
	Transport		Transport
	Public service & professionals		Public service & professionals
	Other		Other
	Domestic service		Domestic service
	Non-employed		
Non-employed family member	Agriculture	Non-employed	Non-employed
	Fishery		
	Mining		
	Manufacturing and construction		
	Commerce		
	Transport		
	Public service & professionals		
	Other		
	Domestic service		
	Non-employed		

We also constructed suicide rates by industrial classification by prefecture. The numerator of suicide rates is the number of suicides in the primary, secondary, and tertiary industries, and the denominator is the prefecture population. The primary industry includes suicides in agriculture and fisheries, the secondary industry includes suicides in mining and manufacturing & construction, and the tertiary industry includes suicides in commerce, transport, public service & professionals, other and domestic service.

Table 8: Definition of suicide rate by occupational and industry classification

Variable	Definition
Employed suicide	Total number of suicides in agriculture, fishery, mining, manufacturing & construction, commerce, transport, public service & professionals, other, and domestic service.
Employed suicide rate	Employed suicide divided by prefecture population
Non-employed suicide	From 1923 to 1931, total number of suicides in non-employed and non-employed family member. From 1932 to1936, the number of suicides in non-employed.
Non-employed suicide rate	Non-employed suicide divided by prefecture population
Primary industry suicide	Total number of suicides in agriculture and fishery.
Primary industry suicide rate	Primary industry suicide divided by prefecture population
Secondary suicide	Total number of suicides in mining and manufacturing & construction.
Secondary suicide rate	Secondary industry suicide divided by prefecture population
Tertiary suicide	Total number of suicides in commerce, transport, public service $ professionals, other, and domestic service.
Tertiary suicide rate	Tertiary industry suicide divided by prefecture population

Table 8 provides the definitions of these suicide rates. Table 9 shows the summary statistics for these suicide rates. Table 9 shows that the male-employed suicide rate is the highest compared to the other suicide rates. Next, the table shows that the

Table 9: Summary descriptive statistics for suicide rates in occupational and industry

variable	N	Mean	St.Dev.	Min	Max
Total, the employed	658	12.6	3.3	2.5	20.8
Total, the non employed	658	7.6	2.7	0.2	15.8
Total, the primary industry	658	7.4	2.9	0.7	15.7
Total, the secondary industry	658	2.0	0.9	0.2	6.0
Total, the tertiary industry	658	3.3	1.2	0.0	7.3
Male, the employed	658	18.8	4.8	4.4	34.1
Male, the non employed	658	6.5	2.5	0.0	18.2
Male, the primary industry	658	10.5	4.0	1.2	20.6
Male, the secondary industry	658	3.4	1.4	0.0	10.5
Male, the tertiary industry	658	5.0	1.9	0.0	12.4
Female, the employed	658	6.5	2.5	0.3	14.2
Female, the non employed	658	8.8	3.5	0.0	20.4
Female, the primary industry	658	4.3	2.3	0.0	11.8
Female, the secondary industry	658	0.6	0.6	0.0	3.5
Female, the tertiary industry	658	1.6	0.7	0.0	4.2

Notes: All Suicide rates are calculated per 100,000 population

suicide rates for employed persons, male primary industry suicide rates, and female non-employed persons are higher than the other suicide rates.

Figure 5 presents the results of an event study DID analysis that estimates the impact of fiscal stimulus on suicide rates in the employed and the non-employed. The DID regressions in this subsection include pre-determined covariates and economic shock variables. The top panel of Figure 5 shows that the fiscal stimulus decreased suicide rates for total and male employed. The bottom panel in Figure 5 shows that the fiscal stimulus reduced suicide rates for both male and female non-employed persons.

Figure 6 presents the DID estimates for the effect of the fiscal stimulus on suicide rates by industry. Figure shows that the fiscal stimulus did not affect the suicide rate in the primary industry (top panel of Figure 6). However, the fiscal stimulus reduced the suicide rate in the secondary (middle panel of Figure 6) and tertiary (bottom panel of Figure 6) industries. These results suggest that the effect of the fiscal stimulus on the suicide rate in the employed occurred through a reduction in the number of suicides in the secondary and tertiary industries. Figure 6 also shows no clear relationship between the fiscal stimulus and the male suicide rate in the tertiary sector.

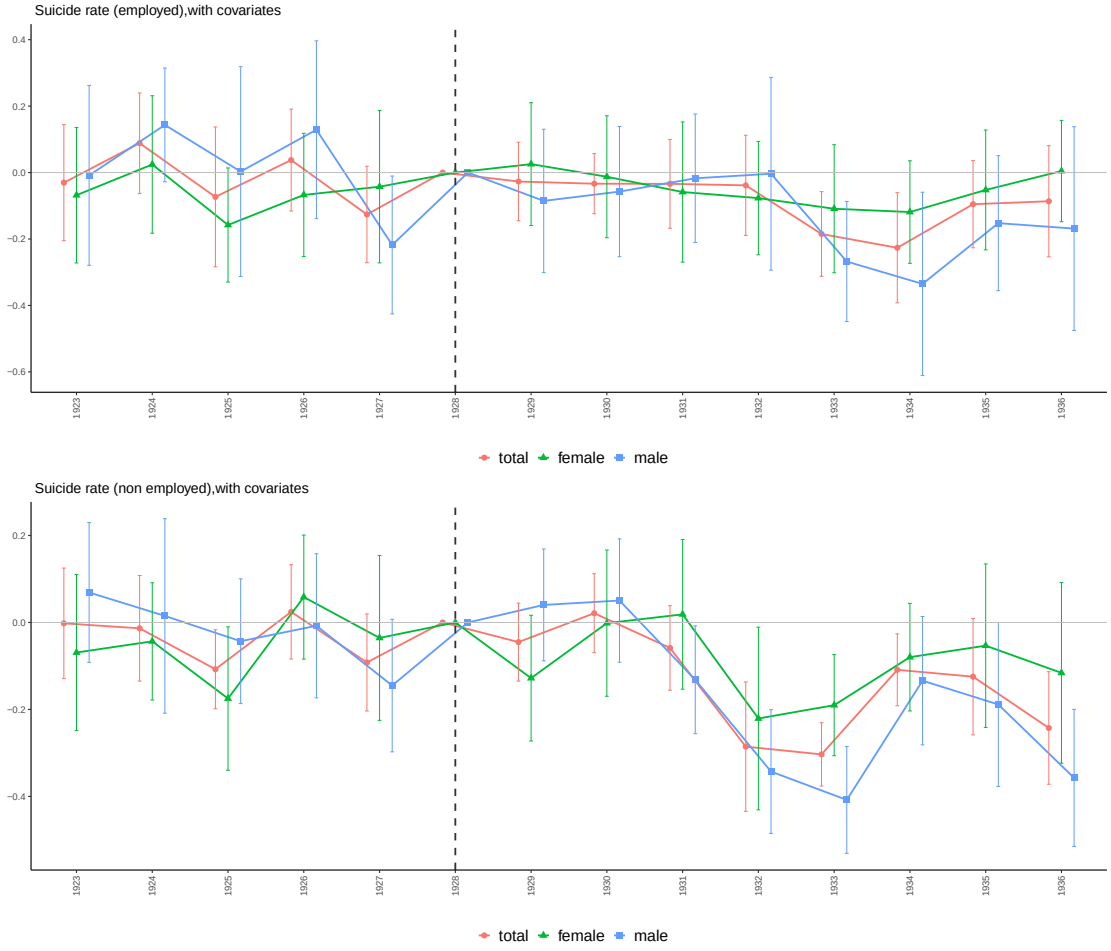
Figure 7 shows the results of the DID estimates for the suicide rates in the employed and non-employed in the sample of tertiary industry ratio above and below the median. In prefectures with the tertiary industry ratio above the median (left panel of Figure 7), during the fiscal expansion period (1932-1935), DID estimates

for the employed suicide rates and non-employed are consistently negative and often different from zero. However, in prefectures with tertiary industry ratio below the median (right panel of Figure 7), the confidence intervals for the DID estimates for both the employed and non-employed suicide rates are hardly far from zero during the period of fiscal expansion (1932-1935) (although some estimates are below zero).

Figure 8 shows the results of the DID estimates for the suicide rate by each industry in samples with the tertiary industry ratio above and below the median. Figure 8 shows that the fiscal stimulus had no effect on the suicide rate in prefectures with the tertiary industry ratio below the median (right panel of Figure 8) and that the fiscal stimulus reduced the suicide rate in prefectures with the tertiary industry ratio above the median (left panel of Figure 8). For the total suicide rate in the secondary industry and the male suicide rate (middle panel of Figure 8 left), the 1934 estimates are below zero. In the total suicide rate in the tertiary industry (bottom panel on the left of Figure 8), the DID estimates for 1932-1934 are below zero. For the female suicide rate in the tertiary industry (bottom panel on the left of Figure 8), the DID estimates are below zero from 1933 to 1936. These results suggest that the reduction in suicide rates due to fiscal stimulus was also caused by a reduction in the number of female suicides in the tertiary industry in urban areas and a reduction in the number of male suicides in the secondary industry.

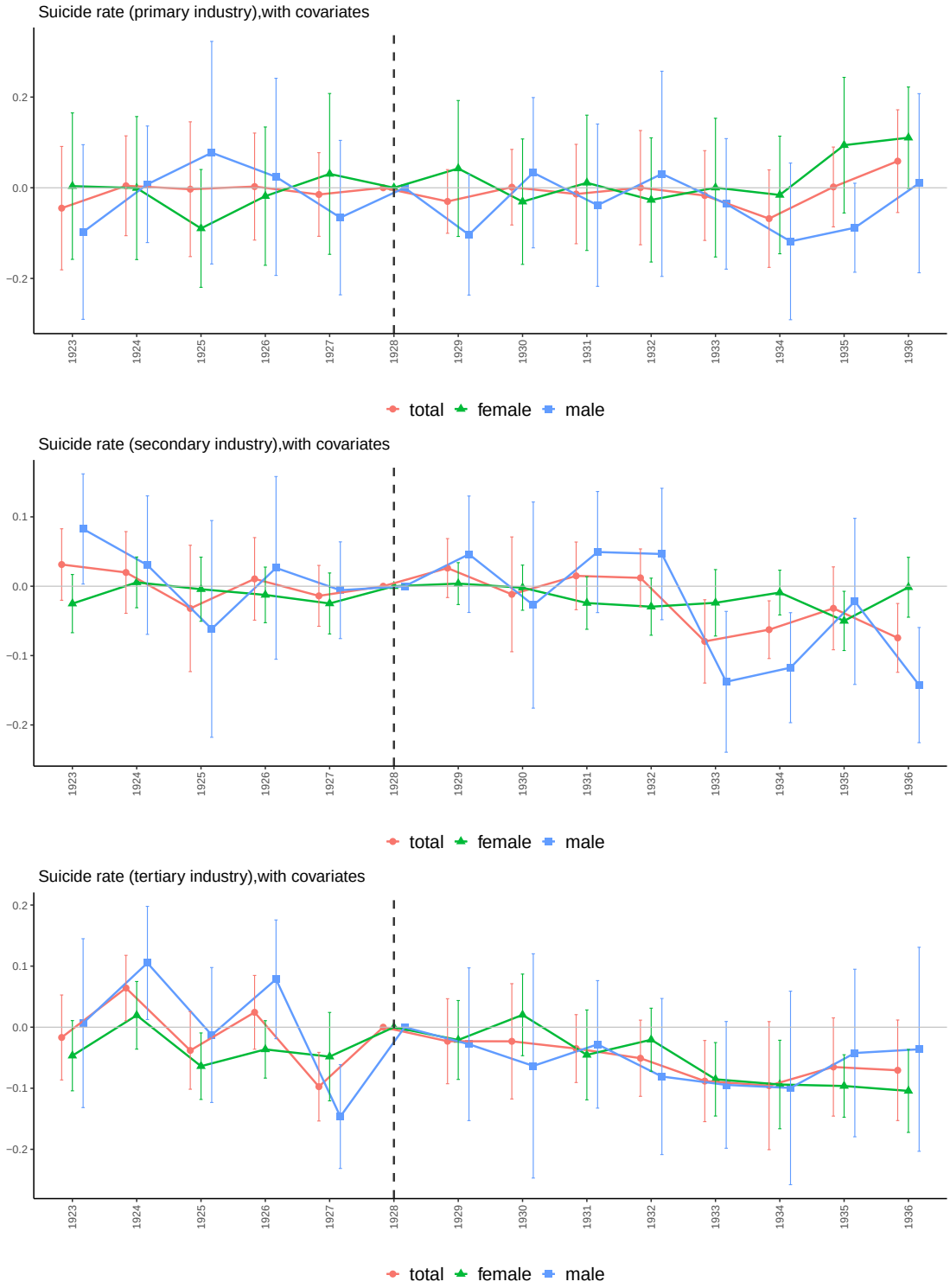
The results in this subsection suggest that in some large urban prefectures, male employed in secondary industries and female employed in tertiary industries may have faced suicide risk. Of course, the results in this subsection do not suggest that people in urban areas faced a greater risk of suicide than those in rural areas. As discussed above, the fiscal stimulus reduced the suicide rate in samples with tertiary industry ratios above the median. We call these prefectures urban prefectures. During the period of fiscal expansion, some urban prefectures increased their fiscal expenditures and large urban prefectures such as Tokyo and Kanagawa reduced their fiscal expenditures (see Figure 3). Therefore, the results in this subsection suggest that the male employed in the secondary industry and the female employed in the tertiary industry in Tokyo and Kanagawa may have suffered during the fiscal expansion period. Fiscal stimulus in prewar Japan may not improve the living standards of these people.

Figure 5: DID estimates for employed and non employed suicide rates



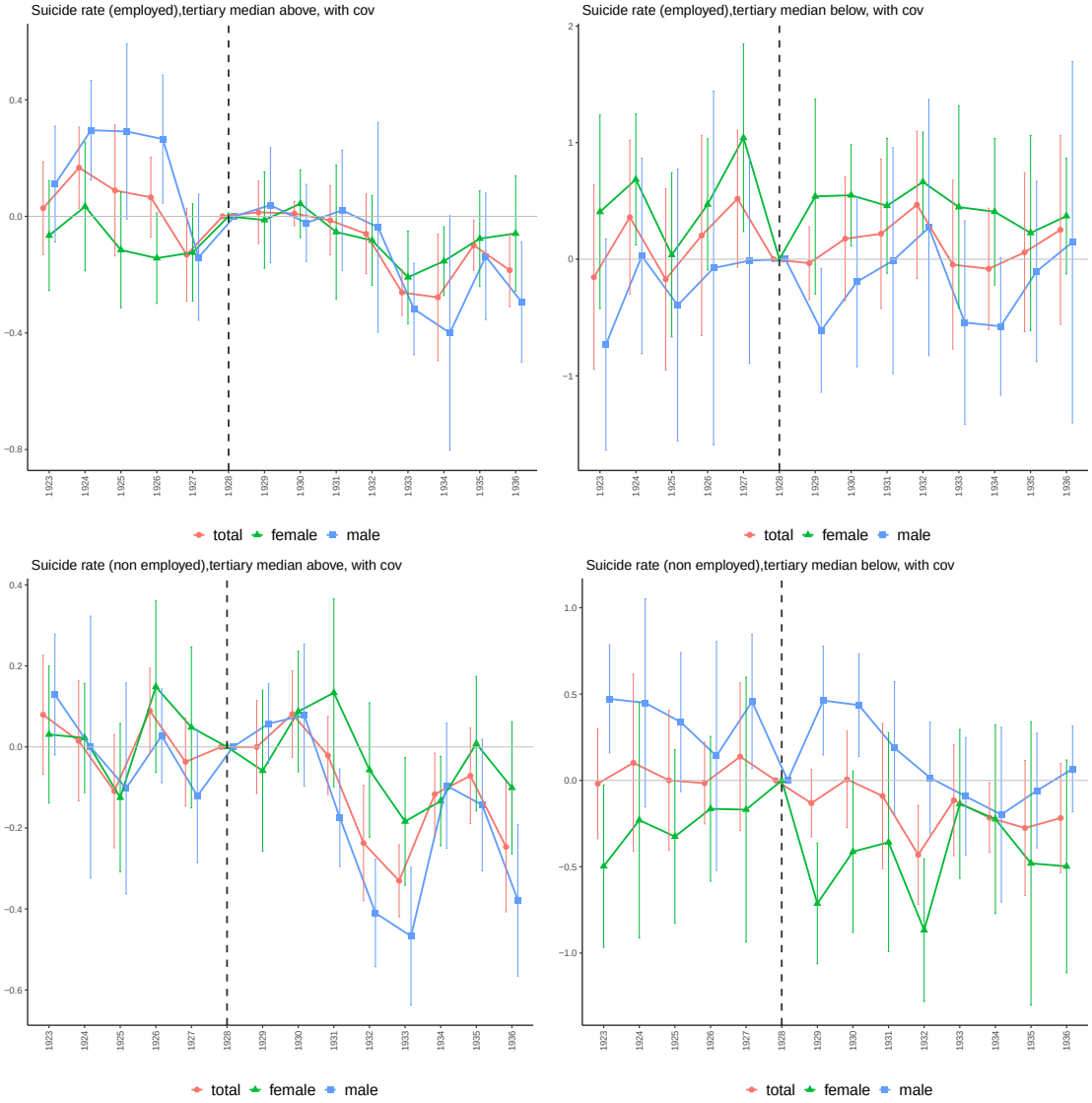
Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in (1). Outcome variables are the employed and non employed suicide rates. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

Figure 6: DID estimates for the suicide rates by the industry classification



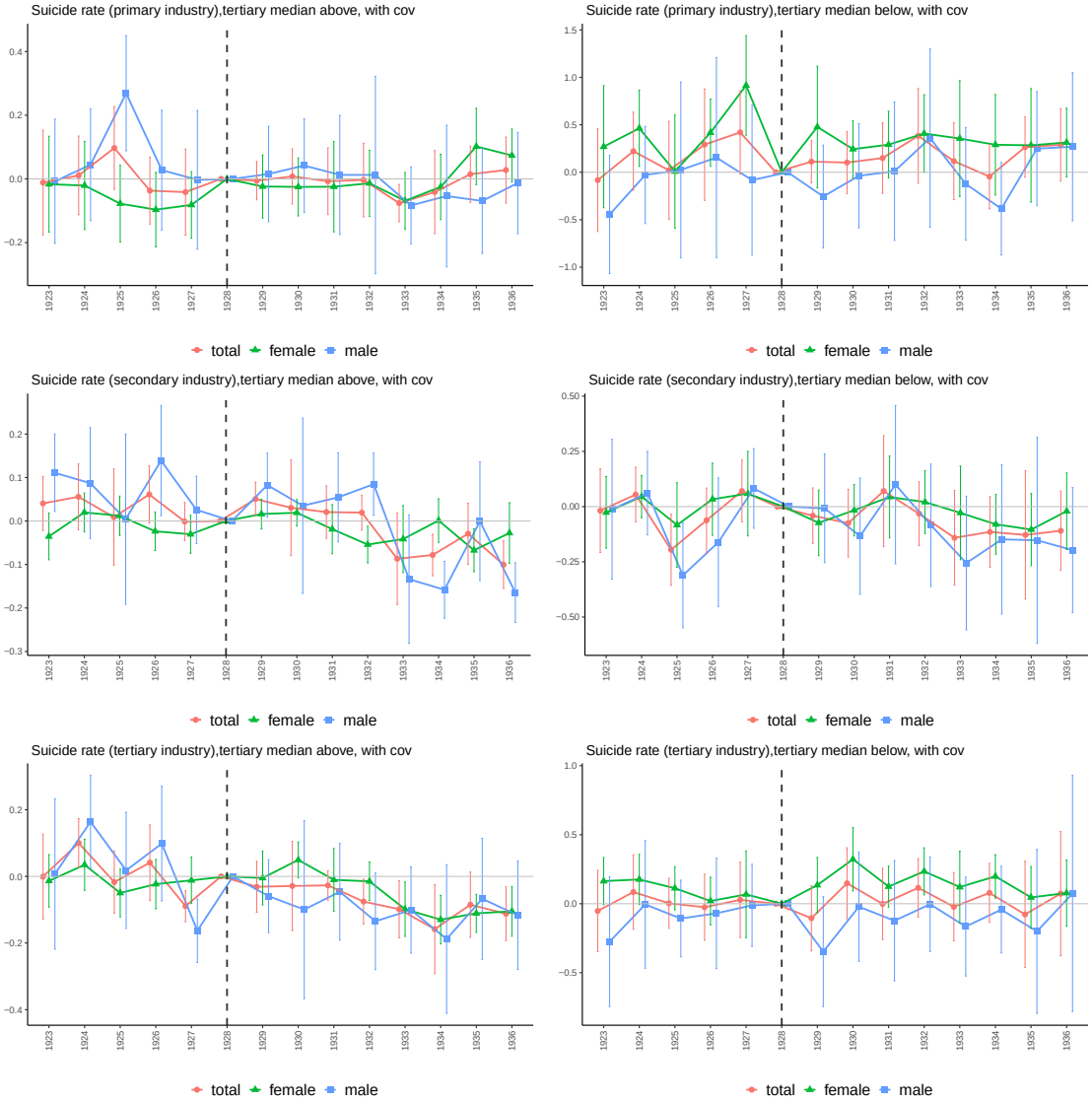
Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1). Outcome variables are the suicide rates by the industry classification. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

Figure 7: DID estimates for suicide rates, by tertiary industry ratio



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1). Outcome variables are the employed and non employed suicide rates. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

Figure 8: DID estimates for suicide rates by industry, by tertiary industry ratio



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variables are the suicide rates by the industry classification. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

8.2 Three types of possible suicide factors

Suicide is a complicated phenomenon and therefore various factors affect the suicide rate (Chen et al., 2012; Frasquilho et al., 2016; Ridley et al., 2020; WHO, 2014). In this section, we focus on three types of possible suicide factors, that is, economic, epidemiological, and familial conditions.

First, as economic conditions, we use the taxable income of personal income tax and the number of tenancy disputes. The taxable income is an indicator of people's economic status and can be considered a mediator variable between fiscal stimulus and the suicide rate. Fiscal stimulus improves people's employment opportunities and income levels, and income improvement can reduce suicide. The number of tenancy disputes can be an indicator of the economic condition of farmers. In prewar Japan, farmers sometimes collectively asked for reductions or exemptions of rent from landlords and these social movements are counted as tenancy disputes. If fiscal expansion improved the economic status of farmers, the number of tenancy disputes would decrease.

Second, as epidemiological conditions, we use total (crude) and infant mortality as the health status variables. Although it may be counterintuitve, several studies reported that economic downturn(e.g. the unemployment rate increase) reduces total and infant mortality (Ruhm, 2000). In other words, people's health condition tends to be improved during a recession. We thus need to interpret carefully the relationship between fiscal stimulus and mortality.

Third, as familial conditions, we examine marriage, divorce, and fertility rates. Chen et al. (2009) pointed out that strengthening social ties is a factor in reducing the suicide rate. Thus the marriage and birth rates increase may be negatively correlated with the suicide rate. In turn, the increase in the divorce rate is expected to increase the suicide rate.

We first conduct the event-study DID to examine the impact of fiscal stimulus on the economic conditions, that is, the taxable income and the tenancy dispute rate. The taxable income of individual income tax at the prefecture level is taken from tax statistics in 1924 -1936 and then divided by prefecture population. Note that, in prewar Japan, the taxpayer of individual income tax was in the high-income class. The number of tenancy disputes is taken from the Statistical Yearbook of Imperial Japan and then divided by the number of farm households. We call this variable the tenancy dispute rate.

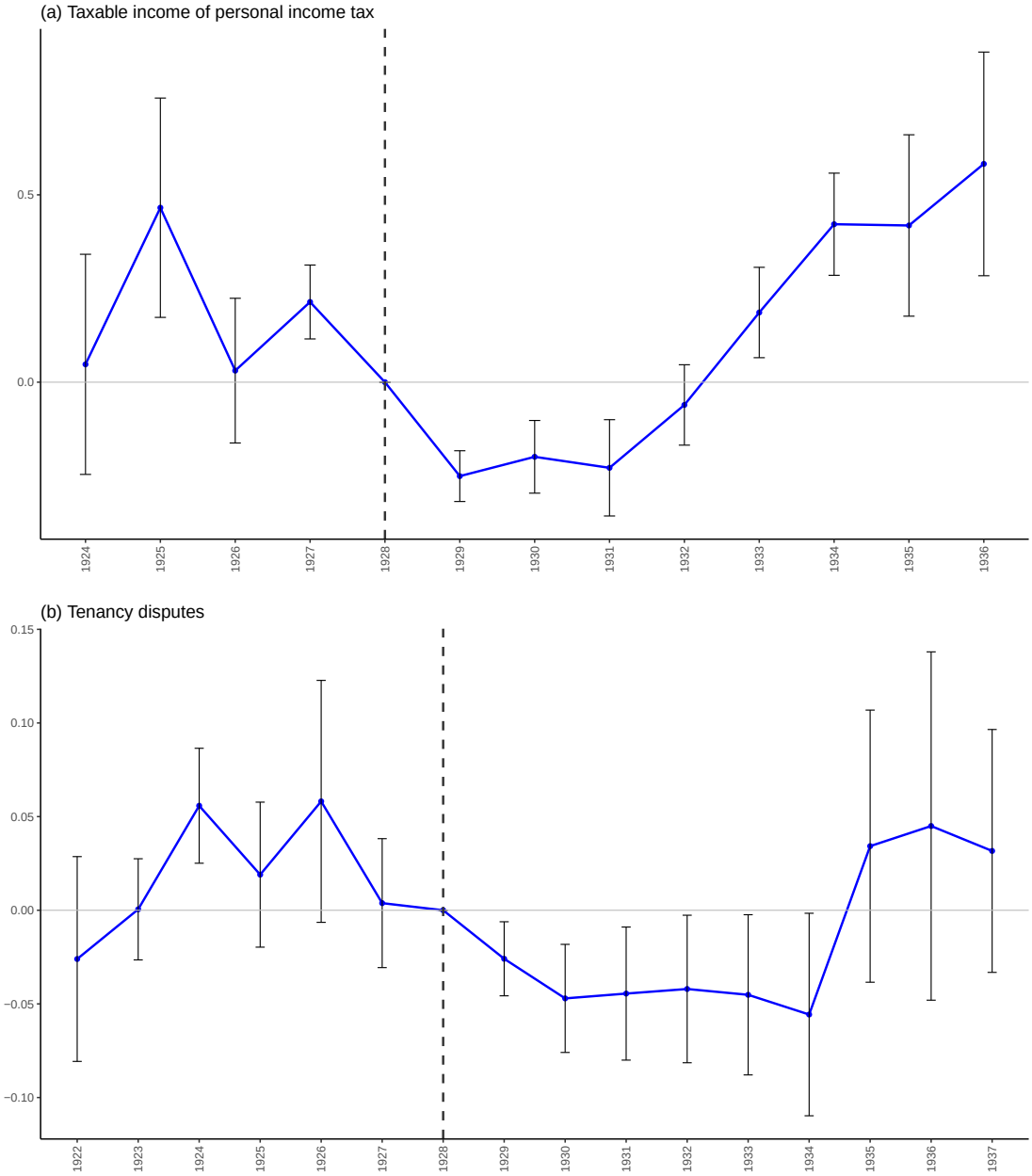
We then examine epidemiological conditions (i.e., total(crude) mortality rate and infant death rate) and familial conditions (i.e., marriage rate, divorce rate, and birth rate). These statistics are taken from Statistics from the Ministry of Health, Labour and Welfare.[9]

Figure 9 shows the results of event-study DID estimation for the economic condi-

[9] https://www.mhlw.go.jp/www1/toukei/kjd100_8/index.html

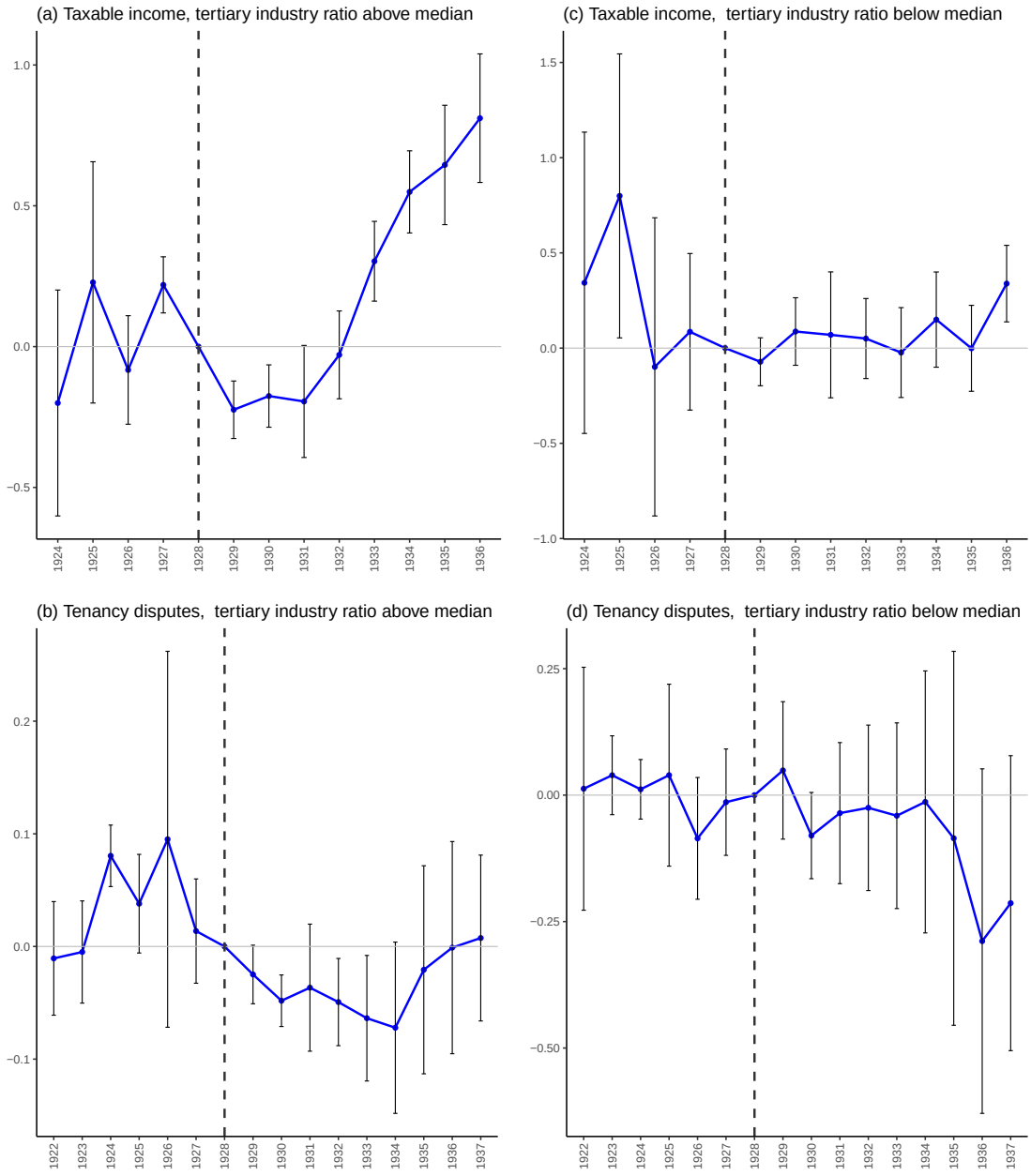
tions. First, some pre-trends(.e. confounding outcome trends) exist in the results of both outcomes. Second, the DID estimates of the fiscal stimulus on taxable income increased from 1931 (upper graph). These estimates are consistently positive and significantly different from zero. This result suggests that fiscal stimulus contributed to the increase in taxable income. Third, the DID estimates of the fiscal stimulus on the number of tenancy disputes are below zero from 1929. The DID estimates are almost the same in 1930-34. This result suggests that fiscal stimulus did not reduce the number of tenancy disputes.

Figure 9: DID estimates for taxable income and tenancy disputes



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variables are the taxable income of individual income tax and the number of tenancy disputes. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

Figure 10: DID estimates for taxable income and tenancy disputes, subgroups by tertiary industry ratio



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variables are the taxable income of individual income tax and the number of tenancy disputes. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

Figure 10 presents the results of the subgroup analyse in which we split the 47 prefectures into the above-median group (24 observations) and the below-median group (23 observations) based on regional industry-ratio indices. Figure 10 shows estimation results for above-mean and below-mean samples Figure respectively(left panel (a) (b) and right panel (c)(d)). For the taxable income, left panel (a) and (c) in Figure 10 suggest that the baseline results may be driven by above-mean (i.e. more urban) prefectures. For the number of tenancy disputes, right panel (b) and

Table 11: DID estimates for mortality and family variables, with covariates

	Total death rate	Infant death rate	Marriage rate	Divorce rate	Birth rate
Period 1900s	−0.035	−1.804**	−0.030	−0.021**	−0.026
	(0.102)	(0.781)	(0.042)	(0.011)	(0.122)
Period 1910s	−0.010	−0.795**	−0.010	−0.009*	−0.136*
	(0.057)	(0.385)	(0.023)	(0.006)	(0.070)
Austerity period (1929-31)	0.096**	0.336	0.008	−0.003	−0.011
	(0.042)	(0.325)	(0.013)	(0.003)	(0.035)
Expansion period(1932-35)	0.108**	0.087	0.020	−0.008**	0.094**
	(0.044)	(0.495)	(0.014)	(0.003)	(0.037)
Post Expansion period(1936-)	0.104*	0.351	0.008	−0.014***	−0.001
	(0.062)	(0.532)	(0.029)	(0.004)	(0.059)
Num.Obs.	1869	1869	1869	1869	1869
R2	0.906	0.932	0.858	0.929	0.926
R2 Adj.	0.874	0.908	0.809	0.904	0.901

* p < 0.1, ** p < 0.05, *** p < 0.01

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total death rate, infant death rate, marriage rate, divorce rate, and birth rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in equation (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

(d) in Figure 10 suggest that fiscal stimulus did not reduce the number of tenancy disputes regardless of the sample split.

Table 11 shows the regression results for epidemiological and familial conditions. First, the fiscal stimulus increased the total mortality rate. This result is consistent with that of Toffolutti and Suhrcke (2019) which found that fiscal stimulus increased the mortality rate using the EU28 panel data. It is unlikely that the rise in mortality rates was directly the cause of the decline in the suicide rate. The social group attributed to the increase in deaths may differ from the social group attributed to the increase in suicides. Total and infant mortality rates tend to be pro-cyclical, while the suicide rate tends to be counter-cyclical (Ruhm, 2000; Toffolutti and Suhrcke, 2019). Second, Table 11 shows that the fiscal stimulus reduced the divorce rate and increased the birth rate. These results suggest that the fiscal stimulus may affect the suicide rate through the changes in family relationships or social ties.

We summarise the above results. Some mechanisms may be suggested to explain why fiscal stimulus reduces the suicide rate. The results in this section suggest that fiscal stimulus reduce the suicide rate through the influence of family relationship and income.

9 Conclusion

Exploiting regional variations in the increase in local spending during the Great Depression in Japan, we examine how expansionary local spending during the Great Depression in Japan mitigated suicide in 1932-1938. We also investigate whether our estimation results differ depending on regional socio-economic differences before the Great Depression.

Our findings are summarized as follows. First, we find a clear and robust suicide-mitigating effect of the local fiscal expansion during the Great Depression in Japan. This is an important finding that has not been addressed in previous studies on the Great Depression.

Second, we observe the suicide-mitigating effect of local spending both in urban and rural regions, but the observed effect is stronger and more robust in urban regions. It implies that the suicide prevention by the local fiscal expansion during the Great Depression in Japan might have worked mainly in urbanized, not rural areas.

Third, we may need to interpret our main finding, not as suicide prevention by fiscal expansion, but as suicide exacerbation by fiscal contraction, at least partly. It is because one of the main drivers of the variation in local spending during the Takahashi Fiscal Policy in the urbanized areas is not the fiscal expansion but rather the fiscal contraction in Tokyo and Kanagawa, two large metropolitan prefectures. We need to address this effect heterogeneity by further examining the characteristics of the local fiscal expansion during the Great Depression.

Fourth, both in the baseline and subgroup analyses, suicide mitigation effect of the fiscal expansion is robustly observed for men. This may be reasonable because the direct targets of the Takahashi Fiscal Policy were male workers who lost their jobs under the Great Depression. At the same time, treatment-variation heterogeneity and effect heterogeneity observed in the subgroup analyses suggest that fiscal variation during the fiscal expansion period affected male workers in urban areas and male tenant farmers in rural areas in quite different ways.

Fifth, results on the suicide rate by industry and some other outcomes imply the following mechanism: an increase in fiscal expenditure in relatively urbanized improve the economic and familial conditions of the unemployed and workers in these areas, which in turn results in a decrease in suicide rates.

Finally, while we provide some evidence of the impact of the expansionary fiscal policy on suicides using historical panel data, we do not fully address how it happened. Future research on this question should be undertaken.

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Appendices

A Variable definitions and Data sources

Table A.1: Variable definitions and data sources

Variable	Definition	Data source
Local government variable		
Total local government Expenditure per capita	Total local government Expenditure/Population	Naimusho Tokei Hokoku
Outcome variable (per 100k)		
Total suicide rate	Total suicides/Population	Shiin tōkei
Female suicide rate	Female suicides/Female population	Shiin tōkei
Male suicide rate	Male suicides/Male population	Shiin tōkei
Total sucide rates by Police statistics	Total suicides/Population	Naimusho Tokei Hokoku,Keisatu tōkei
Female sucide rates by Police statistics	female suicides/Population	Naimusho Tokei Hokoku,Keisatu tōkei
male sucide rates by Police statistics	male suicides/Population	Naimusho Tokei Hokoku,Keisatu tōkei
Control variable		
Gross agricultural product (per capita)	Gross agricultural product/population	Prewar Japan Prefectural Gross Product Database
National direct tax revenue (per capita)	National direct tax revenue/population	Shuzeikyoku Tokei Nenposho
Gross prefectural product	Gross prefectural product in 1925	Prewar Japan Prefectural Gross Product Database
Factory Output(per capita)	Total factory output/population	Kojo Tokei Hyo

Notes: For the yearly data of the total local government expenditure per capita that are used for the construction of the increase in local expenditure induced by the Takahashi economic policy based on equation (1). The data is real values. Total local government expenditure is the sum of prefecture,city, and village expenditure. Prefecture-level aggregated suicide statistics are based on residential addresses. In this paper we use the suicide statistics taken from Statistics on Causes of Death in the Japanese Empire.

B Source of Statistics

Japan Ministry of Finance ed , Shuzeikyoku Tokei Nenposho (Annual Statistical Report of the Tax Bureau 主税局統計年報書)

Cabinet Statistics Bureau ed.Nihon Teikoku shiin tōkei (Statistics on Causes of Death in the Japanese Empire 日本帝国死因統計/死因統計)

Cabinet Statistics Bureau ed, Nihon Teikoku jinkō dōtai tōkei (Vital Statistics of Population in Imperial Japan, 日本帝国人口動態統計)

Ministry of Home Affairs ed, Keisatsu Tokei Hokoku (Police Statistics Report 警察統計報告)

Metropolitan Police Department ed, Keishicho Tokei syo (Metropolitan Police Department statistics 警視庁統計書)

Home Ministry,Dainihon Teikoku Naimusho Tokei Hokoku (大日本帝国内務省統計報告)

Statistical Yearbook of Imperial Japan (Dainihon Teikoku Tokei Nenkan 大日本帝国統計年鑑)

Huken Tokeisho (Prefectural Statistics 府県統計書)

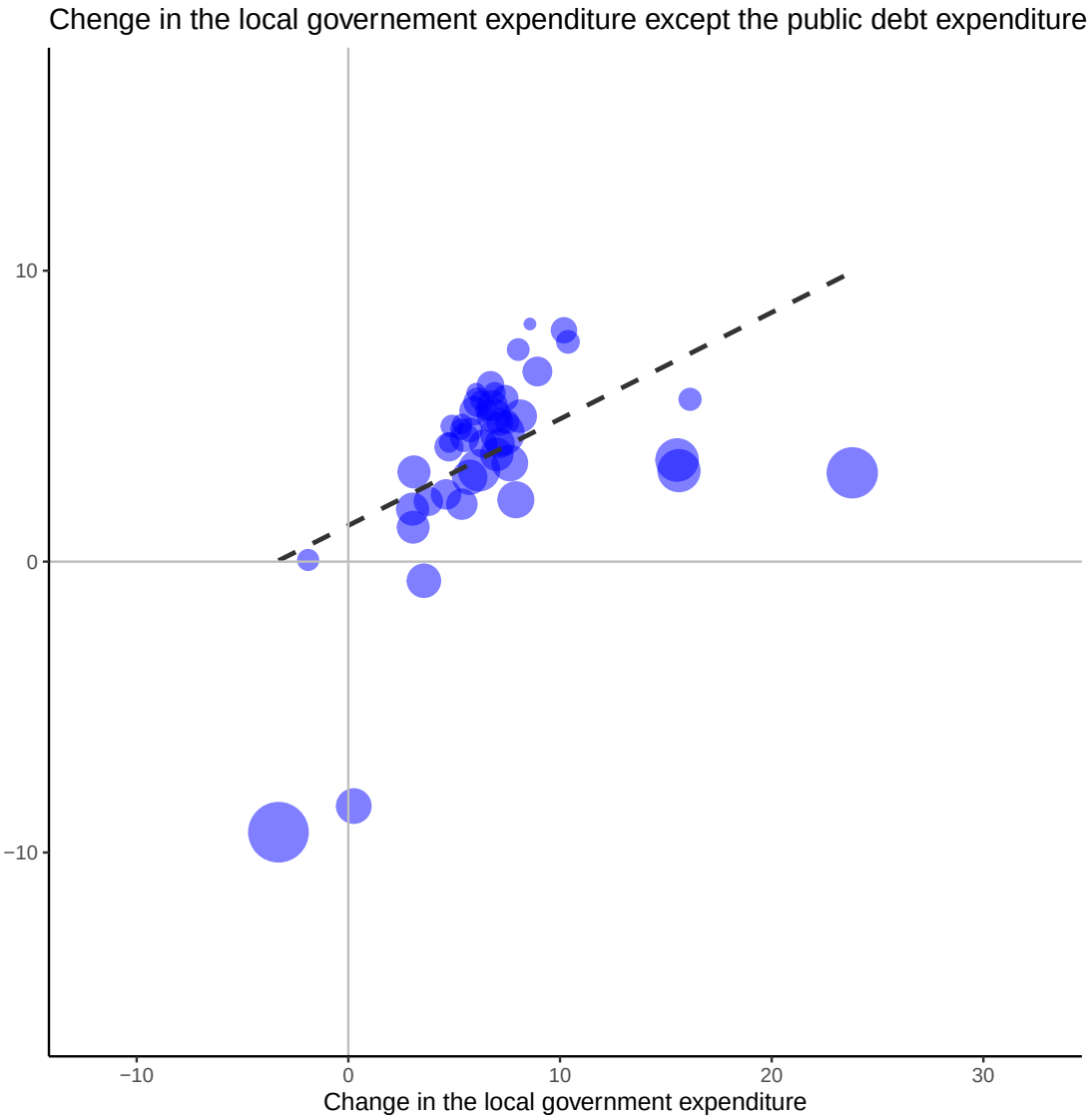
Kojo Tokei Hyo (Manufacturing Census 工場統計表)

Prefectural Statistics are obtaind from Prefectural Statistics Online (J-DAC)
(https://myrp.maruzen.co.jp/j_dac/pso/)

Prewar Japan Prefectural Gross Product Database
https://www.ier.hit-u.ac.jp/Japanese/databases/index.html.

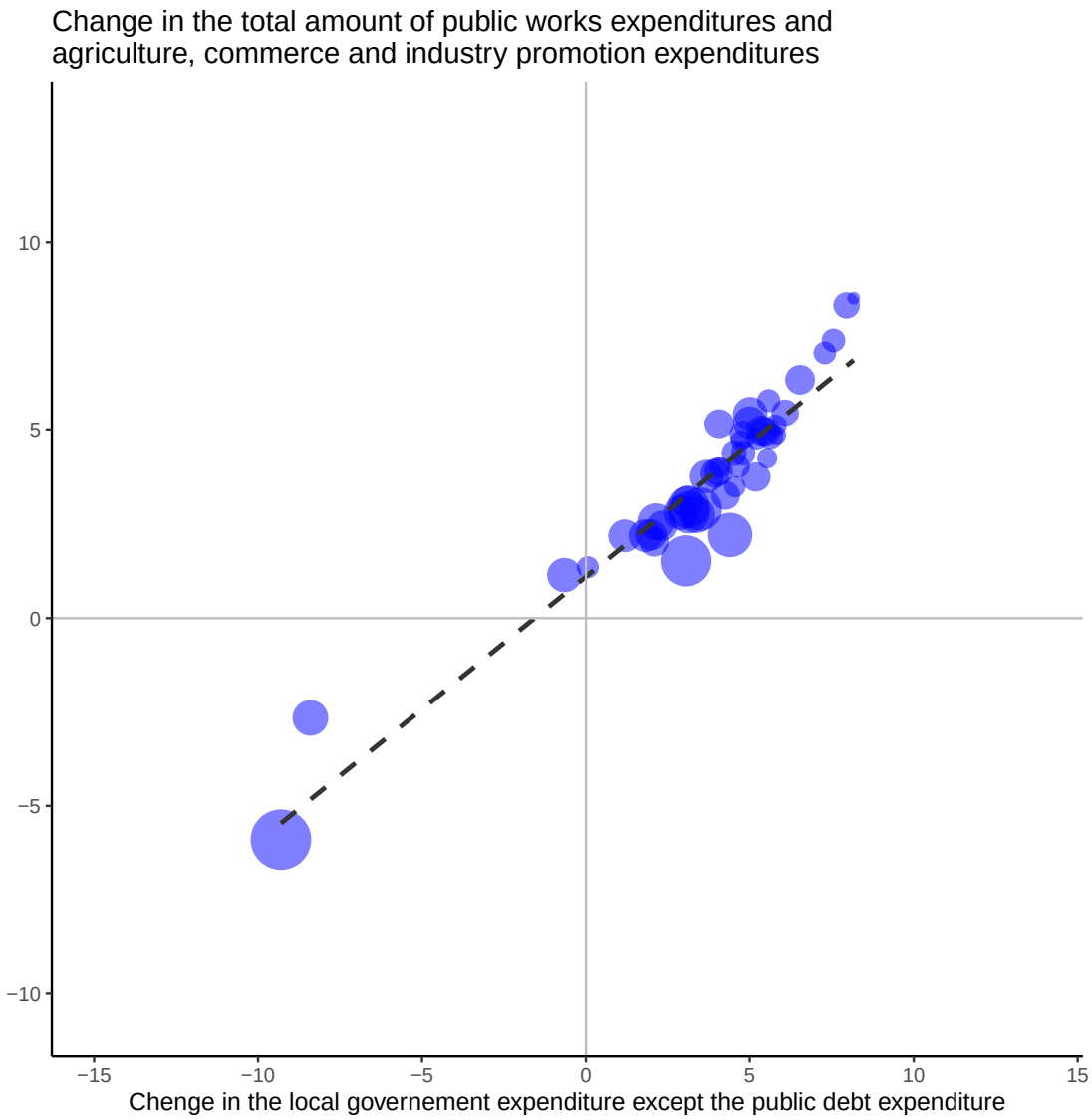
C Scatter plots among alternative treatments

Figure C.1: Scatter plot of the baseline and alternative treatments



Notes: The X axis is the baseline treatment variable of the change in local public expenditure whereas the Y axis is the alternative treatment variable of the change in local public expenditure excluding the public debt payments. Sources: See Table A.1 in Appendix A

Figure C.2: Scatter plot of the alternative treatments



The X axis is the alternative treatment variable of the change in local public expenditure excluding the public debt payments whereas the Y axis is another treatment variable of the change in the expenditures on public infrastructure and business support. Both changes are calcluated based on equation (1). R-Squared of the estimated regression line is 0.89. Sources: See Table A.1 in Appendix A

Table D.1: DID estimates for suicide rates, without covariates

	Total	Female	Male
Period 1900s	−0.197*	0.060	−0.376***
	(0.113)	(0.108)	(0.134)
Period 1910s	−0.140**	0.023	−0.242***
	(0.070)	(0.059)	(0.092)
Austerity period(1929-31)	0.091***	0.173***	0.068
	(0.027)	(0.057)	(0.051)
Expansion period I(1932-33)	−0.198***	−0.032	−0.301***
	(0.033)	(0.058)	(0.048)
Expansion period II(1934-35)	−0.128	0.114	−0.268***
	(0.080)	(0.091)	(0.104)
Post expansion period(1936-)	−0.178	0.145	−0.330**
	(0.111)	(0.103)	(0.131)
Num.Obs.	1880	1880	1880
R2	0.857	0.825	0.810
R2 Adj.	0.849	0.816	0.800

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. Sources: See Table A.1 in Appendix A

D Result of DID estimates with the split expansion period.

Table D.2: DID esimtaes for suicide rates, with covariates

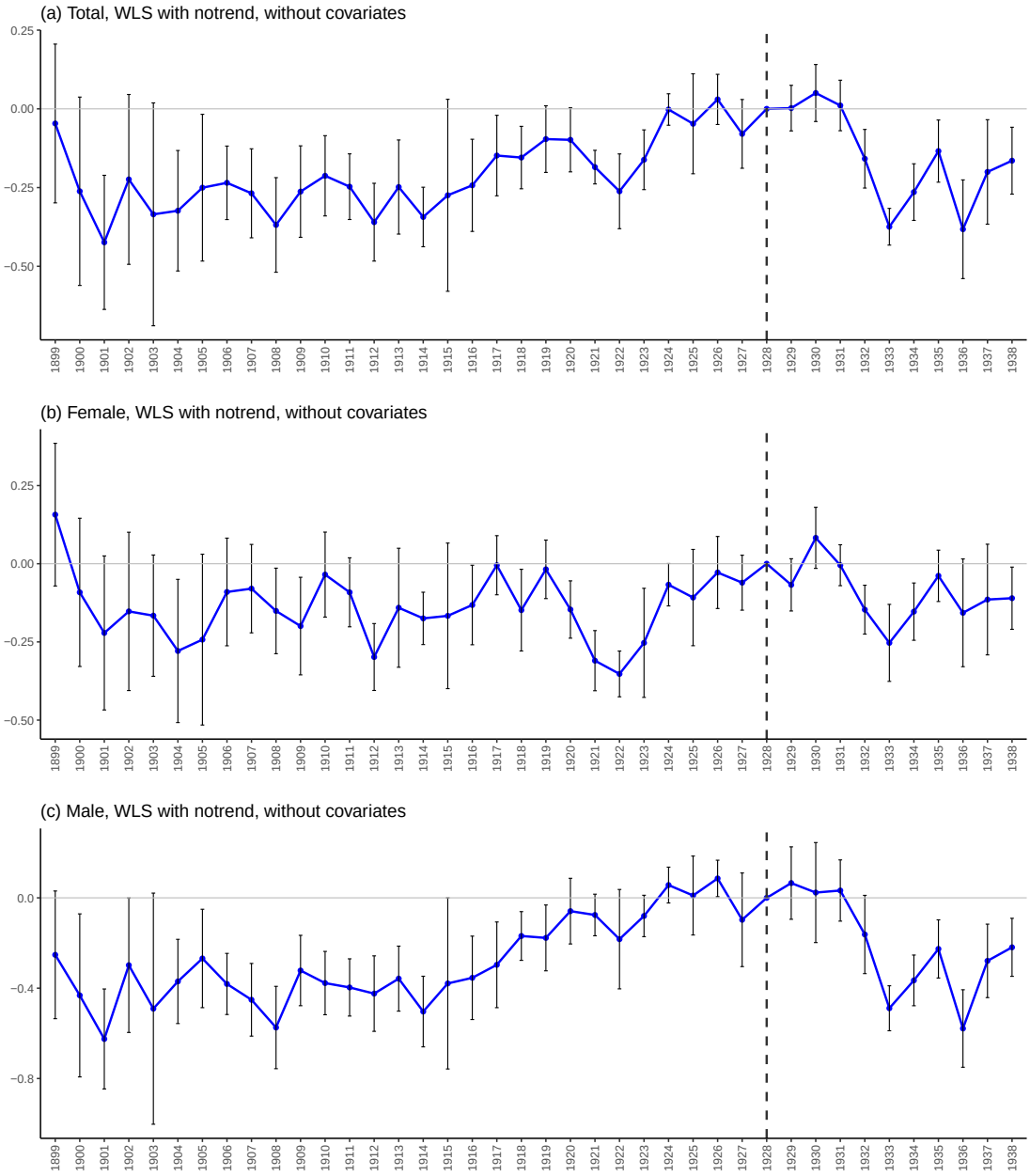
	Total	Female	Male
Period 1900s	−0.029	0.065	−0.115
	(0.101)	(0.116)	(0.108)
Period 1910s	−0.020	0.057	−0.107
	(0.067)	(0.078)	(0.080)
Austerity period(1929-31)	−0.021	0.120	−0.107
	(0.056)	(0.090)	(0.094)
Expansion period I(1932-33)	−0.343***	−0.171**	−0.505***
	(0.089)	(0.083)	(0.177)
Expansion period II(1934-35)	−0.216**	0.049	−0.407***
	(0.105)	(0.087)	(0.152)
Post expansion period(1936-)	−0.142**	0.053	−0.280***
	(0.065)	(0.066)	(0.102)
Num.Obs.	1869	1869	1869
R2	0.911	0.870	0.873
R2 Adj.	0.880	0.825	0.829

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Notes: Estimation incorporates time-varying estimates which can be obtained from 1900 with this model specification. The outcome variables in the analysis are the total suicide rate, female suicide rate, and male suicide rate. Each row shows coefficients from a regression of outcome on the interaction term between the treatment variable and each period dummy. The reference years are 1920-28. All results are weighted least squares(WLS) estimates. WLS estimates are weighted by prefecture population size, but prefectural linear trends are not incorporated. The treatment variable is the size of an increase in local government defined as in (1). Standard errors are reported in parentheses. Robust standard errors are clustered at the prefecture. The DID regression include pre-determined covariates and economic shock variables. Sources: See Table A.1 in Appendix A

E Result of event study DID without covariates

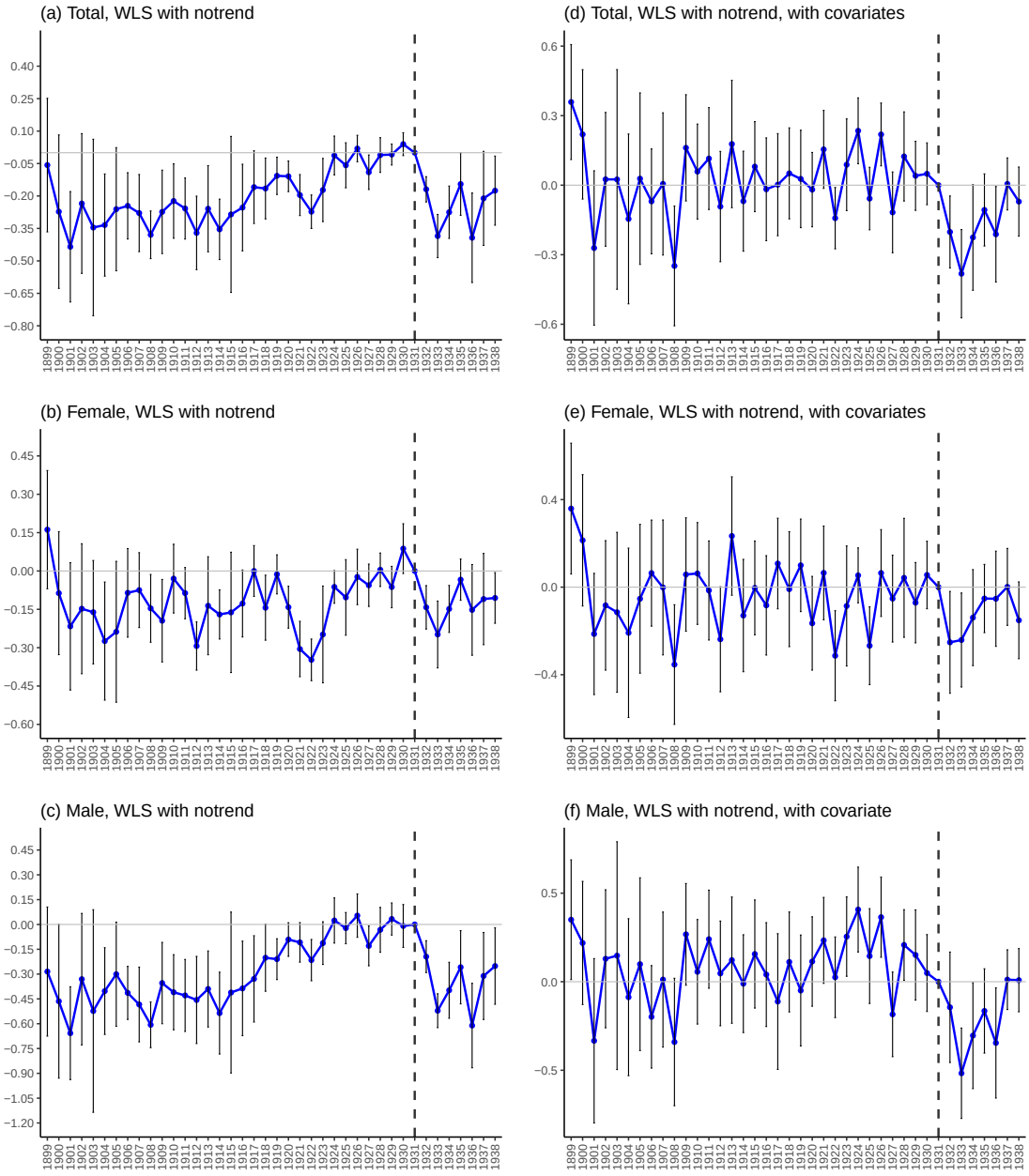
Figure E.3: DID estimates for suicide rates



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variable is the total suicide rate. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

F Result of event study DID with 1931 as the reference year

Figure F.4: DID estimates for suicide rates



Notes: Each plot indicates a point estimate and a vertical line indicates a 95% confidence interval based on a robust standard error clustered by prefecture. The treatment variable is the increase in local government expenditure defined as in equation (1).Outcome variable is the total suicide rate. WLS estimation is weighted by prefecture population size. Sources: See Table A.1 in Appendix A

G Results of OLS

Table G.1: Results of time-varying OLS estimate without covariates

	Total	Female	Male
1900s	−0.107	0.060	−0.273*
	(0.130)	(0.108)	(0.155)
1910s	−0.081	0.023	−0.188*
	(0.081)	(0.059)	(0.107)
Inoue period(1929-31)	0.094*	0.173***	0.024
	(0.052)	(0.057)	(0.079)
Takahashi period(1932-35)	−0.076	0.041	−0.182*
	(0.077)	(0.061)	(0.100)
post Takahashi period(1936-)	0.012	0.145	−0.106
	(0.120)	(0.103)	(0.143)
Num.Obs.	1880	1880	1880
R2	0.874	0.825	0.827
R2 Adj.	0.868	0.816	0.818

* p < 0.1, ** p < 0.05, *** p < 0.01

Table G.2: Results of time-varying OLS estimate with covariates

	Total	Female	Male
1900s	−0.013	0.065	−0.091
	(0.104)	(0.116)	(0.116)
1910s	−0.036	0.057	−0.132
	(0.073)	(0.078)	(0.088)
Inoue period(1929-31)	0.020	0.120	−0.075
	(0.077)	(0.090)	(0.107)
Takahashi period(1932-35)	−0.216**	−0.061	−0.362**
	(0.098)	(0.065)	(0.155)
post Takahashi period(1936-)	−0.079	0.053	−0.201*
	(0.077)	(0.066)	(0.119)
Num.Obs.	1869	1869	1869
R2	0.909	0.870	0.870
R2 Adj.	0.878	0.825	0.824

* p < 0.1, ** p < 0.05, *** p < 0.01

Table G.3: Results of time-varying OLS estimate with covariates

	Total	Female	Male
1900s	−0.013	0.065	−0.091
	(0.104)	(0.116)	(0.116)
1910s	−0.036	0.057	−0.132
	(0.073)	(0.078)	(0.088)
Inoue period(1929-31)	0.020	0.120	−0.075
	(0.077)	(0.090)	(0.107)
Takahashi period(1932-33)	−0.278***	−0.171**	−0.375**
	(0.096)	(0.083)	(0.180)
Takahashi period(1934-35)	−0.153	0.049	−0.349**
	(0.114)	(0.087)	(0.160)
post Takahashi period(1936-)	−0.079	0.053	−0.201*
	(0.077)	(0.066)	(0.119)
Num.Obs.	1869	1869	1869
R2	0.909	0.870	0.870
R2 Adj.	0.878	0.825	0.824

Table G.4: Results of time-varying OLS estimate with covariates, with trends

	Total	Female	Male
1900s	0.028	0.119	−0.061
	(0.161)	(0.187)	(0.194)
1910s	−0.052	0.050	−0.156
	(0.093)	(0.119)	(0.112)
Inoue period(1929-31)	0.029	0.124	−0.061
	(0.081)	(0.103)	(0.106)
Takahashi period(1932-35)	−0.200*	−0.055	−0.338**
	(0.118)	(0.124)	(0.166)
post Takahashi period(1936-)	−0.057	0.062	−0.167
	(0.123)	(0.143)	(0.157)
Num.Obs.	1869	1869	1869
R2	0.929	0.885	0.896
R2 Adj.	0.903	0.841	0.856

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$